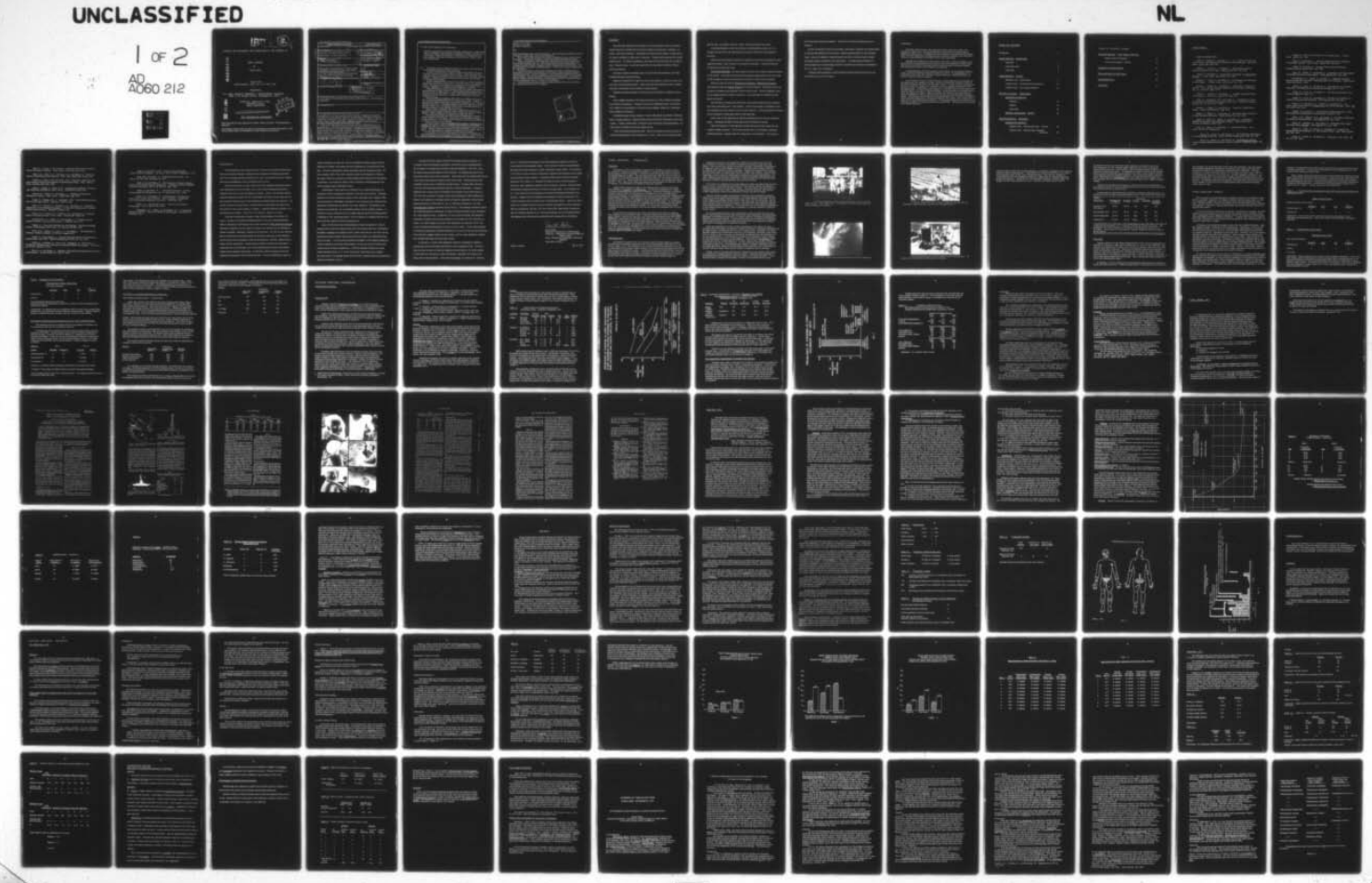
AD-A060 212 MIAMI UNIV FLA DEPT OF DERMATOLOGY F/G 6/5
FUNGOUS AND BACTERIAL SKIN INFECTIONS IN THE TROPICS.(U)
AUG 78 D TAPLIN DADA17-71-C-1084
UNCLASSIFIED NL

1 OF 2
AD
A060 212



FUNGOUS AND BACTERIAL SKIN INFECTIONS IN THE TROPICS (U)

FINAL REPORT

by

David Taplin

August 1978
(For the period 1 June 1971 to 31 May 1976)

Supported by

U.S. ARMY MEDICAL RESEARCH & DEVELOPMENT COMMAND.
Office of the Surgeon General, Washington, D.C. 20314.

Contract No. DADA-17-71-C-1084
University of Miami
Miami, Florida 33101

DDC DISTRIBUTION STATEMENT

This document has been approved for public release and sale: Its distribution is unlimited.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
FUNGOUS AND BACTERIAL SKIN INFECTIONS IN THE TROPICS,

5. TYPE OF REPORT & PERIOD COVERED
Final Report, 1 June 1971 - 31 May 1976

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Prof. David Taplin

8. CONTRACT OR GRANT NUMBER(s)
DADA-17-71-C1084

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Department of Dermatology, U. of Miami School of Medicine, Box 016960, Miami, Fla. 33101

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Medical Research and Development Command, Office of the Surgeon General, Washington, D.C. 20315

12. REPORT DATE
August 1978

13. NUMBER OF PAGES
108

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
114 p.

15. SECURITY CLASS. (of this report)

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
This document has been approved for public release and sale: Its distribution is unlimited.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
skin infections, climate, hygiene, insect vectors, streptococcal pyoderma, furunculosis, gram negative bacteria, epidemiology, field teams (health of), Colombia, Venezuela, Costa Rica, Guatemala, Vietnam, Panama, Tinea corporis, Tinea cruris, Tinea pedis, clothing (continued on back of page)...

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Bacterial skin infections in the tropics are the predominant cause of dermatological disease in civilians and are directly related to temperature, humidity, exposure, and living conditions. Substandard housing and poor hygiene, biting and vector insects contribute to high rates of infection. Tropical skin infections are usually streptococcal. In military populations, personnel on field operations are at highest risk. Support troops, even in the tropics, have a much lower incidence of streptococcal pyoderma. (continued on back)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

AD A062694

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

19. Key Words continued from front page:

occlusion, griseofulvin, nystatin, tolnaftate, clotrimazole, antibacterial soaps, miconazole, hydrocortisone, diagnostic methods, selective culture media, streptococcus aureus, dermatophytes, candida albicans, pseudomonas, aeromonas hydrophila, (disaster relief, scabies, head lice, sunscreens).

20. Currently available deodorant soaps do not prevent skin infections, but chlorhexidine gluconate looks promising.

Epidemic furunculosis is related to close social contact, and may be more common than most physicians realize. Early treatment with antibiotics plays a significant role in prevention of new furuncles among contacts. Antibiotic resistant strains of bacteria pose new problems in cutaneous microbiology.

Severe fungal infections of the skin may attack up to 70% of military personnel in hot humid environments. Occlusion is the most significant factor, and appears to be related to accumulation of CO_2 under damp clothing. (King et al., Letterman Army Institute of Research).

Combined therapy of tinea corporis/cruris with topical miconazole/hydrocortisone is highly effective. Hydrocortisone alone makes these infections worse in the tropics. Topical clotrimazole is effective in the treatment of dermatophytosis, but tinea pedis is difficult to treat and usually recurs.

Ultramicrosized griseofulvin (PEG-500) is as effective as twice the dose of microsize griseofulvin in the treatemnt of T. pedis. Both are more effective than placebo pills, but clinical response is slow, and only partially successful. A nystatin/tolnaftate cream was effective in treating tinea cruris, but a 5% allergic reaction rate to the thimerosal preservative rendered it unacceptable in this form.

Flower vases in hospitals represent a significant reservoir of opportunistic gram negative bacteria, many of which are resistant to antibiotics. Flowers should not be introduced in high risk areas,

Aeromonas hydrophila, and other aquatic bacteria pose a threat to persons injured in wet terrain. It was the most predominant pathogen among survivors of a jet crash in the Everglades, and has been reported in at least 16 more cases in Florida.

Selective culture media for Streptococcus pyogenes, Staphylococcus aureus, dermatophyte fungi and Candida albicans have been developed. Dessicated swabs may be used for streptococcal pyoderma in lieu of fresh media. Archaic diagnostic methods for fungal infections require experience. New techniques for unskilled investigators are needed.

The incidence of common skin infections in hot humid climates can be predicted from data accumulated under this contract. Little accurate data is available for desert conditions. (continued on next page)

DADA 17-71-C1084
Abstract continued...

20.

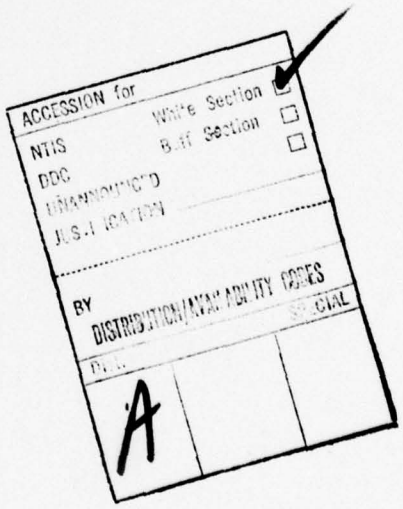
and local endemic areas of exotic diseases. Cold and temperate climates are not conducive to high attack rates of skin infections.

Most cases of skin infections in military populations are not seen by dermatologists. Technology transfer to "front line" medical personnel is needed.

Strict precautions to avoid infections among field teams in the tropics are successful if rigidly enforced. 74% of team members not on precautions, developed diarrheal disease, compared with 6% among teams on precautions. 12% of unprotected personnel developed hepatitis. There were no cases among teams on precautions.

In spite of extensive work on the etiology, prevalence, incidence and epidemiology of common skin infections in the tropics, clinical implementation of existing knowledge, methods of diagnosis, and particularly preventive measures lag far behind. The global profile of hazards is still incomplete. A strong military/civilian research programme in dermatology remains a desirable and necessary component of the U.S. Army R & D structure.

Combined field operations by elite military/civilian teams have proven to be a cost effective use of R & D dollars.



SUMMARY

Bacterial skin infections in the tropics are the predominant cause of dermatological disease in civilians and are directly related to temperature, humidity, exposure, and living conditions. Substandard housing and poor hygiene, biting and vector insects contribute to high rates of infection. Tropical skin infections are usually streptococcal. In military populations, personnel on field operations are at highest risk. Support troops, even in the tropics, have a much lower incidence of streptococcal pyoderma.

Currently available deodorant soaps do not prevent skin infections, but chlorhexidine gluconate looks promising.

Epidemic furunculosis is related to close social contact, and may be more common than most physicians realize. Early treatment with antibiotics plays a significant role in prevention of new furuncles among contacts.

Antibiotic resistant strains of bacteria pose new problems in cutaneous microbiology.

Severe fungal infections of the skin may attack up to 70% of military personnel in hot humid environments. Occlusion is the most significant factor, and appears to be related to accumulation of CO_2 under damp clothing. (King et al., Letterman Army Institute of Research).

Combined therapy of tinea corporis / cruris with topical miconazole / hydrocortisone is highly effective. Hydrocortisone alone makes these infections worse in the tropics. Topical clotrimazole is effective in the treatment of dermatophytosis, but tinea pedis is difficult to treat and usually recurs.

Ultra microsized griseofulvin (PEG - 500) is as effective as twice the dose of microsize griseofulvin in the treatment of T. pedis. Both are more effective than

placebo pills, but clinical response is slow, and only partially successful.

A nystatin/tolnaftate cream was effective in treating tinea cruris, but a 5% allergic reaction rate to the thimerosal preservative rendered it unacceptable in this form.

Flower vases in hospitals represent a significant reservoir of opportunistic gram negative bacteria, many of which are resistant to antibiotics. Flowers should not be introduced in high risk areas.

Aeromonas hydrophila, and other aquatic bacteria pose a threat to persons injured in wet terrain. It was the most predominant pathogen among survivors of a jet crash in the Everglades, and has been reported in at least 16 more cases in Florida.

Selective culture media for Streptococcus pyogenes, Staphylococcus aureus, dermatophyte fungi and Candida albicans have been developed. Dessicated swabs may be used for streptococcal pyoderma in lieu of fresh media. Archaic diagnostic methods for fungal infections require experience. New techniques for unskilled investigators are needed.

The incidence of common skin infections in hot humid climates can be predicted from data accumulated under this contract. Little accurate data is available for desert conditions and local endemic areas of exotic diseases. Cold and temperate climates are not conducive to high attack rates of skin infections.

Most cases of skin infections in military populations are not seen by dermatologists. Technology transfer to "front line" medical personnel is needed.

Strict precautions to avoid infections among field teams in the tropics are successful if rigidly enforced. 74% of team members not on precautions, developed diarrheal disease, compared with 6% among teams on precautions. 12% of unpro-

tected personnel developed hepatitis. There were no cases among teams on precautions.

In spite of extensive work on the etiology, prevalence, incidence and epidemiology of common skin infections in the tropics, clinical implementation of existing knowledge, methods of diagnosis, and particularly preventive measures lag far behind. The global profile of hazards is still incomplete. A strong military/civilian research programme in dermatology remains a desirable and necessary component of the U.S. Army R & D structure.

Combined field operations by elite military/civilian teams have proven to be a cost effective use of R & D dollars.

FOREWORD

This final report covers a five year period from June 1971 to May 1976. Complete accounts of the work performed may be found in the Annual Progress Reports for these years. An attempt has been made here to consolidate the findings under the most appropriate headings relevant to military disability, and where necessary to modify opinions in the light of more recent knowledge.

Although this contract was terminated in May 1976, we have continued to pursue research on skin infections in the tropics, and where applicable, further information has been added to this report which will not be found in previous reports. Data derived from more recent studies is so indicated.

In conducting the research described in this report, the investigators adhered to the "Guide for Laboratory Animal Facilities and Care", as promulgated by the Committee on the Guide for Laboratory Animal Resources, National Academy of Science, National Research Council.

In the conduct of clinical trials overseas, written protocols were submitted to and approved by the Ministry of Health, and/or the appropriate Surgeon General in the case of military populations in each host country. In every instance an approved physician of the host country was requested by us and assigned as monitor for the host government. Additionally, permissions were obtained from the host country professional bodies, who also reviewed protocols. Local physicians were briefed and invited to monitor our studies. Informed consent was obtained from participants in their own language or dialect, and no deviations from accepted protocols were permitted. All data was made available to host governments, who received a preliminary report and debriefing prior to our team leaving the host country, and a final written report of the study following data analysis. Training opportunities were offered to any personnel assigned by host governments and universities. All local laws and customs were strictly observed.

TABLE OF CONTENTS

continued

TABLE OF CONTENTS continued

PUBLICATIONS

Papers-original reports

Blank, H., Taplin, D., and Roth, F. J., Jr.: Electron Microscopic Observations of the Effects of Griseofulvin on Dermatophytes. AMA Arch. Derm. 81:667-680, May 1960.

Sarkany, I., Taplin, D., and Blank, H.: Erythrasma-Common Bacterial Infection of the Skin. JAMA 177:130-132, July 1961.

Taplin, D. and Blank, H.: Microscopic Morphology of Trichophyton rubrum. J. Invest. Derm. 37:523-528, Dec. 1961.

Sarkany, I., Taplin, D. and Blank, H.: The Etiology and Treatment of Erythrasma. J. Invest. Derm. 37:283-290, Oct. 1961.

Sarkany, I., Taplin, D., and Blank, H.: Erythrasma, A Bacterial Disease. Proc. XII International Congress of Dermatology, Washington, DC, pp. 1010-1012, Sept. 1962.

Sarkany, I., Taplin, D., and Blank, H.: Incidence and Bacteriology of Erythrasma. Arch Derm. 85:578-582, May 1962.

Blank, H., Rosenberg, E.W. and Taplin, D.: An Electronic Device for Measuring Sweating and Curaneous Water Loss. Advances in Biology of Skin, Vol. III, pp. 97-107, 1962.

Sarkany, I., Taplin, D., and Blank, H.: Organism Causing Erythrasma. Lancet (7250):304-305, Aug. 1962.

Taplin, D., Rebell, G., and Zaias, N.: The Human Skin as a Source of Mima-Herellea Infections. JAMA 186:952-955, Dec. 1963.

Blank, H., Zaias, N., Taplin, D., and Rebell, G.: Swampfox II, Republic of Panama, Medical Research Report. Walter Reed Army Institute of Research, April 1964.

Zaias, N., Taplin, D. and Rebell, G.: Pitted Keratolysis. Arch. Derm. 92:151-154, August 1965.

Taplin, D., Zaias, N., and Rebell, G.: Environmental Influences on the Microbiology of the Skin. Arch. Environ. Health 11:546-550, Oct 1965.

Zaias, N., Rebell, G., and Taplin, D.: Microsporum rivalieri Vanbreuseghem Isolated from Tinea Capitis in Florida. Sabouraudia 4:201-204, 1965.

Taplin, D.: The Use of Gentamicin in Mycology Media. J. Invest. Derm. 45:549-550, 1965.

Zaias, N. and Taplin, D.: Improved Preparation for the Diagnosis of Mycologic Diseases. Arch. Derm. 93:608-609, May 1966.

Taplin, D. and Zaias, N.: Tropical Immersion Foot Syndrome. Military Medicine 131:814-818, Sept. 1966

Zaias, N., Taplin, D., and Rebell, G.: Evaluation of Microcrystalline Griseofulvin Therapy in Tinea Capitis. JAMA 198:805-807. Nov. 1966.

Ehrenkranz, N.J., Taplin, D., and Butt, P.: Antibiotic-Resistant Bacteria on the Nose and Skin: Colonization and Cross-Infection. Antimicrobial Agents and Chemo. 1966.

Taplin, D., Zaias, N., and Rebell, G.: Skin Infections in a Military Population. Developments in Industrial Microbiology 8:3-12, 1967.

Taplin, D., Zaias, N., and Rebell, G.: Infection by Hippelates Flies. Lancet II (7513):472, Aug. 1967.

Taplin, D., Zaias, N., and Blank, H.: The Role of Temperature in Tropical Immersion Foot Syndrome. JAMA 202:546-549, Nov. 1967.

Ward, C.G., Clarkson, J.G., Taplin, D., and Polk, H.C., Jr.: Wood's Light Fluorescence and Pseudomonas Burn Wound Infection. JAMA 202: 1039-1041, Dec. 1967.

Taplin, D. and Zaias, N.: The Etiology of Pitted Keratolysis. Proc. XIII Congressus Internationalis Dermatologias, Munchen, 1967.

Davis, C.M., Fulghum, D.D., and Taplin, D.: The Value of Neomycin in a Neomycin-Steroid Cream. JAMA 203:298-300, Jan. 1968.

Zaias, N., Ioannides, G., and Taplin, D.: Dermatitis from Contact with Moths (genus Hylesia). JAMA 207:525-527, Jan. 1969.

Taplin, D., Zaias, N., Rebell, G., and Blank, H.: Isolation and Recognition of Dermatophytes on a New Medium (DTM). Arch. Derm. 99:203-209, Feb. 1969.

Zaias, N., Taplin, D., and Rebell, G.: Mycetoma. Arch. Derm. 99: 215-225, Feb. 1969.

Blank, H., Taplin, D., and Zaias N.: Cutaneous Trichophyton mentagrophytes Infections in Vietnam. Arch. Derm. 99:135-144, Feb. 1969.

Polk, H.C., Ward, C.G., Clarkson, J.G., and Taplin, D.: Early Detection of Pseudomonas Burn Infection. Arch. Surg. 98:292-295, March 1969.

Taplin, D., Allen, A.M. and Mertz, P.M.: Experience with a New Indicator Medium (DTM) for the Isolation of Dermatophyte Fungi. Proc. Internat. Symp. Mycoses PAHO 205, 1970.

Kelly, C., Taplin, D., Allen, A. M.: Streptococcal Ecthyma, Treatment with Benzathine Penicillin G. Arch. Derm. 103:306-310, March 1971.

Allen, A.M., Taplin, D., and Twigg, L.,: Cutaneous Streptococcal Infections in Vietnam. Arch. Derm. 104:271-280, Sept. 1971.

Taplin, D., Bassett, D.C.J., and Mertz, P.M.: Foot Lesions Associated with Pseudomonas cepacia. LancetII: 568-571, 1971.

Polk, H.C., Ward, C.G., Clarkson, J.G., and Taplin, D.: Ultraviolet flourescence of Pseudomonas aeruginosa: An Aid to the Diagnosis and Treatment of Burn Wound Infection. Research in Burns, 1971.

Davis, C.M., Garcia, R.L., Riordon, J.P., and Taplin, D.: Dermatophytes in Military Recruits. Arch. Derm. 105:556-560, April 1972.

Nsanzumuhire, H., Taplin, D., and Lansdell, L.: Pyoderma Among Ugandan Children. East African Medical J. 49:84-88, Feb. 1972.

Taplin, D.: The Use of Antibiotics in Dermatology. Advances in Biology of Skin, Pharmacology and the Skin, Vol. XII, pp. 315-323, 1969.

Allen, A.M., Taplin, D., Lowy, J.A., and Twigg, L.: Skin Infections in Vietman. Military Medicine 137:295-301, August 1972.

Taplin, D., and Lansdell, L.: Value of Desiccated Swabs for Streptococcal Epidemiology in the Field. Applied Microbiology 25:135-138, Jan. 1973.

Taplin, D., Lansdell, L., Allen, A.M., Rodriguez, R., and Cortes, A.: Prevalence of Streptococcal Pyoderma in Relation to Climate and Hygiene. The Lancet, pp. 501-503, March 10, 1973.

Allen, A.M. and Taplin, D.: Epidemic Trichophyton mentagrophytes Infections in Servecemen. JAMA 226:864-867, Nov. 19, 1973.

Taplin, D. and Mertz, P.M.: Flower Vases in Hospitals as Reservoirs of Pathogens. The Lancet, pp. 1279-1281, December 8, 1973.

Allen, AM. and Taplin, D.: Tropical Immersion Foot. The Lancet, pp 1185-1189, November 24, 1973.

Allen, A.M. and Taplin, D.: Skin Infections in Eastern Panama; Survey of Two Representative Communities. American Journal of Tropical Medicine and Hygiene, Vol. 23, pp. 950-956, Sept. 1974.

Taplin, D. and Allen, A.,.: Bacterial Pyodermas. Clinical Pharmacology and Therapeutics, Vol. 16, pp. 905-911, Nov. 1974.

Allen, A.M. and Taplin, D.: Epidemiology of Cutaneous Mycoses in the Tropics and Subtropics: Newer Concepts. Proceedings of the International Symposium of Mycoses. PAHO 304, 1976.

Taplin, D.: Superficial Mycoses. Journal of Investigative Dermatology. Vol. 67, pp. 177-181, 1976.

Blumenthal, D.S., Taplin, D. and Schultz, M.G.: A Community Outbreak of Scabies. American Journal of Epidemiology, 104 (6):667-72, December 1976.

BACKGROUND

The termination of this contract in May 1976 ended an unbroken collaboration with our in-service colleagues dating from the original development of griseofulvin in 1958, through Operation Swampfox II in 1961, our involvement in the Vietnam years up to investigations in the Colombian Army in 1975.

Operation Swampfox II taught us that most of the standard laboratory methods were inadequate for use in the field, but by 1967 we had evaluated and perfected methods which were to prove invaluable in Vietnam. Indeed, the accurate epidemiologic investigation conducted by the LAIR/WRAIR and Miami teams would not have been possible without the newer field techniques developed under our contracts. The results of these combined military civilian efforts are eloquently described in the first volume of the medical history in Vietnam. (Internal Medicine in Vietnam Vol. 1 Skin Diseases in Vietnam, 1965-72 by LTC Alfred M. Allen, M. D. USA).

From these endeavours emerged a clear understanding of the relative frequency, etiology and potentially disabling effects of the most common afflictions likely to diminish the effectiveness and morale of troops in hot, humid environments. That these conditions were not unique to Vietnam was confirmed by our subsequent studies in Uganda, Venezuela, Colombia and Costa Rica. By 1974 we were satisfied that we could rather accurately predict the prevalence and types of skin infections for hot, humid areas, providing we knew the temperature, humidity, altitude and exposure factors (operations). Further point prevalence surveys were not likely to vastly increase our knowledge, and we were approaching the point of diminishing returns on the taxpayers investment. We therefore shifted emphasis toward prevention and evaluation of more effective therapy. We have traditionally sought out

defined populations at high risk, and had established excellent rapport with the Ministries of Health, universities and local authorities in Venezuela and Costa Rica. We have a particularly strong association with the Colombian Army, and more recently (1976-1978) have conducted studies in the Republic of Panama. Our plans called for evaluation of topical antibacterial products in the prevention of pyoderma, and testing the effect of early treatment of dermatophytosis with newly developed topical antifungal creams.

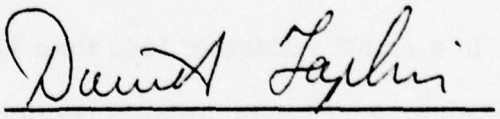
Unfortunately, these plans were curtailed due to political difficulties encountered by other investigators working in Costa Rica and Colombia. Although unrelated to US Army sponsored projects, these difficulties had a negative effect on our proposals in Washington, although we were assured by the respective host Ministries of Health that our projects were fully approved. Nevertheless, this contract was terminated, not on scientific grounds, but for political reasons. In fairness it must be said that in view of budget cutbacks and the devastating effects of inflation on the "purchasing power" of R & D dollars it is unlikely that this contract could have survived more than another year.

Now, in 1978 the in-house dermatological research programme is also in jeopardy and we have been informed that one of the reasons given for a substantial potentially crippling cut in support is that a belief exists that we now have "all the information needed to handle skin diseases that may attack our combat troops anywhere overseas". As the previous principal investigator of the largest extramural contract relating to world-wide skin problems, and the one who has worked most closely with the in-house programmes, I find this statement difficult to accept. General Richard Taylor, M. D. in his foreward to "Skin Diseases in Vietnam" sees this work as "an eloquent lesson in the need for continued study and preparation during the interludes of peace".

Ten years after the pioneer work by the research teams in Vietnam, we no further ahead in therapeutic approaches, and in fact may be losing ground to the emergence of multiply drug resistant cutaneous pathogens. The role, if any, for topical anti-bacterial agents is still in dispute. No significant advances have been made toward better insect repellents. Tinea pedis and its complications remain at the same level among US troops as they were in 1945. Friction blisters still constitute a major cause of disability among recruits. We know little more than we did in 1944 concerning cutaneous problems in desert operations. Cutaneous diphtheria was a major cause of disability and evacuation in the Afrika Korps in 1941 and 1942, and there is strong evidence that subsequent civilian epidemics in Europe were initiated by returning troops carrying the organisms in skin lesions. (Internal Medicine in World War II, Vol. II, Infectious Diseases pp. 279-319). Mycobacterium ulcerans infections (Buruli ulcer), a devastatingly destructive infection responding poorly to treatment, can attack healthy individuals of any nationality who enter endemic areas. In Nigeria, 21 cases occurred among well-nourished individuals residing in good living conditions on the campus of of the University of Ibadan. In a small village of less than 1500 inhabitants in Costa Rica (1977), 200 cases of cutaneous leishmaniasis occurred in three months. We are only beginning to realize the importance of wound feeding flies as vectors of common skin infections, we do not have a single vaccine for any of them, and our crude diagnostic methods have changed little since the turn of the century.

In summary, we have made significant advances in defining the problems, although gaps in our knowledge still exist for some geographic areas. We have a long way to go in terms of front line diagnosis and prevention. For these reasons I do not share the view that our task is completed, especially in the light of previous lapses in preparedness. I also find encouraging, the report (U.S. Medicine

May 15, 1978) that the President has directed government agencies to become more involved in International Health. If the directives achieve implementation, skin diseases should constitute a major component of these efforts. For example, a 1977 survey of farm workers in Guatemala identified skin infections as the single most prevalent medical problem. (Guatemala Health Sector Assessment USAID, November 1977, Annex 5-7. Extension of Health Services to Finca Workers.) Moreover, other significant problems such as malaria, measles, onchocerciasis, and pesticide intoxication involve the skin as a target organ. In my opinion, the U.S. Army Research and Development Command Dermatological Research Programme, coupled with the availability of experienced civilian contractors is in a unique position to play a positive role in International Health. I know of no other agency in a stronger position to pursue continued investigation of man's interface with his environment, the skin, and I have chosen this Final Report to plead not only for continued support of U.S. Army dermatology, but for an expanded effort with funding which will take into consideration the eroding effects of inflation.



David Taplin
Professor, Department of Dermatology
Professor, Department of Epidemiology and Public Health
Chief, Division of International Community Medicine
University of Miami

Miami, Florida July 4, 1978

FUNGAL INFECTIONS. EPIDEMIOLOGY.

Venezuela.

In February 1973 we investigated reports of an "epidemic" of tinea cruris, or "jock itch", among 367 young men enrolled in a school of Agronomy at Tucupita in the Orinoco Delta of Venezuela. The local terrain and climate were similar to the Mekong Delta in Vietnam. We found that these boys, aged 16-18 had a very low prevalence of T. cruris on entering the school (less than 2%), but within six weeks, the prevalence was 27%. Second year boys had 41% prevalence, and the third year class had 46%. Thus, time at the school was related to the prevalence of infection, and as in Vietnam, we could detect no evidence of acquired immunity.

Unlike combat troops in Vietnam, the infections were caused by the anthrophilic species, T. rubrum and E. floccosum . In this they resembled U.S. troops in training during summer months at Ft. Benning. Extensive sampling of laundered clothing, shower stalls, farm animals and soil failed to reveal an extra-human source of these fungi. Our interpretation was that we were dealing with common human dermatophyte infections, exacerbated by the conditions of high humidity, temperature, and the occlusive nature of the dungarees they were required to wear. Of interest was the fact that only 50% of attempts at culture yielded the fungus. We subsequently discovered that this was related to the aggressiveness of the sampling and amount of material recovered in scraping the lesions. In a later study at the same school, scraping the entire active borders of the lesions yielded the pathogens from 79 of 80 attempts.

In July 1974 we returned to the school, and found 150 of 380 boys suffering from moderate to severe tinea cruris. It should be noted that these are point prevalence figures, which in two separate years indicated that approximately 40% of the population at risk suffered from active infection at the time of the surveys. Post inflammatory hyperpigmentation of the inner thighs on many individuals indicated that the incidence of infections was much higher than 40%. This observation, not quantified at the time, became more signigicant as a result of later studies in Colombia (see below). 15% of the cases of groin dermatitis were due to mixed infections with dermatophyte fungi and Candida albicans, an observation which was also to contribute to significant breakthroughs in Colombia (see below).

Colombian Army.

In September/October 1974, this contract provided liaison, logistical support, personnel and mycological expertise to the LAIR dermatological team under LTC Alfred M. Allen, M.D. The objectives were to increase the field capabilities at LAIR by combining their personnel without previous field training with the experienced Miami team under one collaborative study. A similar approach with WRAIR/Miami teams had proven highly successful in Vietnam. The format for this exercise was to be a survey of Colombian Army units operating or stationed in different climatic areas, much as we had done with streptococcal infections among Colombian children (page 14).

During this operation, new diagnostic methods were evaluated for pyoderma and an attempt was made to standardize methods for isolation of fungi from skin lesions. This evolved into spirited discussions relating to selectivity and sensitivity of diagnostic tests for epidemiologic surveys. The Miami team held the view that a maximum effort should be made to establish a diagnosis by aggressively sampling the most likely source of fungi (active borders, vesicle tops, scales). This requires experience, runs the risk of operator bias in selection, and lacks quantitation. The LAIR approach was based on a standardized method of scraping predetermined body sites, which,although lacking in sensitivity, would eliminate bias and make the interpretation of climatic and environmental effects more accurate.

The results are contained in the LAIR reports for 1974, and showed that recovery rates were low, confirming that successful KOH and culture methods for fungal infections remain more of an art than a science. Two years later, the Miami team resurveyed Colombian Army units, using maximum recovery methods, and achieved a 100% confirmation of tinea cruris/corporis by KOH, and 99% by culture.

These two studies clearly demonstrate the need for new diagnostic techniques which do not rely on specialized experience. The inexperienced researcher has only a 50% chance of obtaining a culture confirmation, even with the best media. Microscopic confirmation by KOH is even worse. In a pilot study, two observers with one year experience each were given 22 positive KOH slides for dermatophytes randomly mixed with 20 negative preparations. They found only five of the positive preparations. A more skilled observer, with 15 years experience, correctly selected 21 of the 22 positive slides.

The most important results of the LAIR/Miami studies in Colombia were unexpected, and like most of the real discoveries from both institutions, were completely unplanned; a horrifying concept to R & D contract officers, but still the hallmark of innovative and unique research. A chance observation in the laboratory in Colombia, coupled with one of the many late night discussions,formed the origin of an entirely new concept of pathogenesis in cutaneous infections.

While demonstrating the trivia of KOH examinations to Dr. Robert D. King, a member of the LAIR team, we noted the frequent occurrence of arthrospore formation in the fungal hyphae, particularly from the more tropical areas. Similarly, Col. Allen patiently explained the mathematical intricacies of peripheral probability to the Miami team as related to the occurrence of concomitant dermatophytosis and candidiasis in the same groin lesions. It was decided to reexamine the hundreds of DTM cultures for the simultaneous recovery of both pathogens. King noted that C. albicans tended to inhibit the growth of dermatophytes in the same culture tube, and later demonstrated this to be due to CO_2 production. He also noted that dermatophytes produced arthrospores under CO_2, and increased their output of "keratin" digesting enzymes. In a final experiment, King and his colleagues showed that there was a drastically increased CO_2 level under damp military uniforms compared with dry clothing.

Finally, we had a physical/biochemical explanation for the repeated observation of exacerbation of fungal infections under occlusion. A dramatic demonstration of this phenomenon was presented in June 1976, again in the Colombian Army. We initiated a study to compare the therapeutic efficacy of miconazole nitrate cream

Occlusive dungarees probably exacerbated tinea cruris in this hot humid climate. Note rubber boots. Investigator at extreme right holds on to pole to maintain erect posture.

Typical case of tinea cruris seen among boys at School of Agronomy.

Frequent contact with soil is a part of daily life, but only one case of geophilic fungus infection was discovered among 358 boys.

Well maintained laundry seemed unlikely mode of transmission. No fungi were isolated from freshly laundered clothing.

versus the same cream plus 1% hydrocortisone, and needed a population with a high prevalence of tinea cruris/corporis. Colombian Army authorities directed us to a small unit in garrison some 25 km. from Barrancabermeja. This unit was engaged in routine patrols of an oil installation situated in a jungle area of constantly high temperature and humidity. During the day, temperatures frequently exceeded 100°F, but dropped to 95°F in the barracks by 11pm! Humidity was seldom below 90%R.H.

We found 55% of the men with severe body ringworm covering all body areas. Most impressive was the confluent highly inflammatory lesions covering the entire abdomen and most of the buttocks, with the borders sharply defined by the contours of their jockey shorts. Investigation revealed that the men had opportunities to wash their underwear but no chance to dry them, a slow process at best in the high humidity and windless conditions. The severity and extent of their lesions, almost all due to E.floccosum were worse than we saw in Vietnam, and I have no doubts that we were observing the real life effects of Dr. King's CO_2 phenomenon.

This story is included to demonstrate a typical result of the collaboration we have enjoyed with our in-service counterparts and why we feel that such joint efforts make the most of the tax payers dollar.

In searching for appropriate study populations among the Colombian Army, we conducted surveys of units in different climatic areas. The results are shown here:

Table 1.

Local (No.)	Temperature °C	Humidity %	Prevalence T. pedis	T.corporis	2 months Incidence
Barranca (115) (El Centro)	28-38	80-90	85%	55%	72%
Barranquilla (256)	24-32	60-70	64%	38%	50%
Santa Marta (348)	26-30	20-30	*32%	17%	20%
Guajira (75)	30-40	10-20	**85%	4%	9%

*Low prevalence of T. pedis due to men being allowed to go to the beach with boots off.
**Note the low prevalence of T. corporis in the hot dry climate of Guajira. The prevalence of T. pedis, however, is the same as that in the hot humid area of El Centro. This is due to the fact that the "climate" inside the occlusive boots is hot and humid.

Costa Rica.

During a survey of Costa Rican schoolchildren in 1975, we had an opportunity to examine 63 children in a high school (altitude 400 M.) All were post pubertal. One in every four students had T. pedis, one in ten had T. corporis, and every fifth child suffered from tinea versicolor. There was no difference between boys and girls, a factor we attributed to the occlusive clothing and shoes worn as school uniform. In contrast, none of 113 children, 7 to 13 years old in a school only 2km. distant suffered from these "post pubertal" fungal infections. Here is yet another repeatedly observed phenomenon deserving further study. Why is prepubertal skin so rarely infected with anthropophilic fungi?

In summary, we have learned much concerning the epidemiology and etiology of fungal infections of the skin. Studies relating climate to prevalence and severity pro-

vide guidelines for predicting likely attack rates and morbidity. The most significant findings indicate the importance of occlusion, and a physical/biochemical explanation resulted from collaborative studies with the LAIR team. The high incidence of T. pedis is directly linked to the wearing of occlusive boots, and can be diminished by exposure of the feet to air. Archaic diagnostic methods are useful epidemiologic tools only in the hands of highly experienced practitioners, and deserve re-evaluation. Field surveys by alert observers invariably spawn new discoveries. We learned little about mechanisms of transmission, and have not been able to identify a major reservoir of anthropophilic fungi in laundered clothing, shower stalls or soil.

FUNGAL INFECTIONS - THERAPY

The occurrence of mixed infections by candida albicans and dermatophyte fungi and the occasional "epidemics" of crural candidiasis we have observed in U.S. military populations suggest the need for topical agents effective against both pathogens. We first elected to study a combination of two old and trusted agents, nystatin and tolnaftate. Both have a long and remarkably safe history virtually devoid of allergenic side effects.

We chose the school of agronomy in Tucupita, Venezuela for the study, and were supplied by the manufacturer with coded tubes of nystatin cream, tolnaftate cream, and a combination of both. Neither the sponsor nor the FDA required a placebo group, since both agents had been accepted as effective. A further cell would have reduced the number of subjects on each treatment and we agreed to omit a control group, a decision we would come to regret.

80 subjects were randomly assigned to one of the three treatment groups. Each had a groin dermatitis confirmed as dermatophytosis, candidiasis, or both by KOH and culture on DTM. At the end of two weeks therapy, during which we observed the use of the products twice per day, more than 80% of the subjects were cleared or markedly improved, regardless of the cream used. However, five of the subjects developed allergic reactions to the products. Patch testing of these subjects gave strongly positive reactions to the preservatives in the cream. Four reacted to the thimerosal, and one to parabens. Although the products were effective agents, this and other studies in the US confirmed a 5-8% rate of allergic reactions, far too high to be considered as an acceptable treatment for tinea corporis/cruris. This allergic reaction to thimerosal appears to be more common in the US and Central America where merthiolate is a popular "antiseptic" lotion. Indeed, positive patch tests to thimerosal are now so common that it is no longer considered a reliable guide to investigation of any particular patient with contact dermatitis.

Of academic interest is the fact that 0.1% thimerosal is a potent antifungal agent, and was used as the standard active treatment of guinea pig infections in the original investigation of tolnaftate. It may well have contributed to the therapeutic success of the creams used in this study. Had we included a "placebo" vehicle, it would also have contained 0.1% thimerosal, and we might have ended up with a four cell study showing no differences. This study has made us increasingly suspicious of so called

"placebo" or supposedly inert vehicles which when tested may show quite active antimicrobial properties. We urge other investigators to test formulations for in vitro activity before initiating clinical trials.

Since Vietnam there have appeared on the market several new topical antifungal agents; haloprogin, clotrimazole and miconazole. They differ from previously available products in that they have "broad spectrum" fungitoxic activity which includes both dermatophytes and yeasts. We have investigated the two imidazole formulations, miconazole and clotrimazole. Complete data on the clotrimazole studies may be found in our 1975 report. Clinical results are reproduced here.

Table 2 . 1% Clotrimazole in polyethylene glycol 400 versus control vehicle polyethylene glycol 400.

Tinea Corporis/Cruris

Clinical response at two weeks:

	excellent	good	fair	no response
Clotrimazole (15)	12	1	1	1
Vehicle (15)	0	3	5	7

Conclusion: 12 of 15 cases of tinea corporis/cruris were completely "cured", (clinically and laboratory neg.). None of the vehicle treated patients were cured. ($P<0.001$).

Table 3 . Clotrimazole versus vehicle.

Interdigital Tinea Pedis

Four weeks treatment:

	excellent	good	fair	no response
Clotrimazole	1	8	2	0
Vehicle	2	2	4	4

$P = 0.045$

Conclusions: These numbers are too small to make definitive statements. The results were similar in other laboratories in this multicentric trial, and indicate that 1% clotrimazole solution is of benefit in interdigitated tinea pedis and statistically is better than the control vehicle. It reduces the severity of the disease, and relieves symptoms. Like other topicals, it cannot claim to be a "cure" for "Athlete's Foot", except for a small proportion of cases.

Table4 Clotrimazole versus vehicle.

Hyperkeratotic Plantar Tinea Pedis

Six weeks treatment.

	excellent	good	fair	no response
Clotrimazole	2	7	3	2
Vehicle	0	4	3	5

Not statistically significant at 5% level.
Combined results of multicentric trial give a p value of 0.044 comparing active drug versus vehicle.

Conclusions: 1% clotrimazole has a beneficial effect on most cases of tinea pedis plantar type, and appears to be better than the control vehicle. Plantar dermatophytosis is difficult to treat, and few cases are "cured" by this therapy.

Combination Miconazole/Hydrocortisone cream for Tinea Cruris/Corporis.

The following study was completed after the termination of contract, but is included here because it is of military relevance.

100 Colombian Army soldiers with severe tinea corporis/cruris were empanelled in this study. All had positive microscopic and culture results at the start of the study. One case was lost to follow up. Average temp: 28-38°C, humidity: 80-90%RH. Twice per day, each man applied, under our supervision either 1% hydrocortisone cream, or 2% miconazole nitrate cream, or a cream containing 2% miconazole and 1% hydrocortisone. Clinical response is shown in Table 5.

Table 5.

	Day 7		Day 14	
Cream	Success*	Failure**	Success	Failure
Hydrocortisone 1%	3	30	2 (6%)	31
Miconazole 2%	22	11	25 (78%)	7
Combination	27	6	32 (97%)	1

*Success = Complete clinical clearing with negative microscopy and culture.

**Failure = Some signs of clinical disease or positive laboratory findings.

Note the higher failure rates for 1% hydrocortisone. Ten subjects became worse on this cream within one week.

Conclusions: The combination cream was superior to m iconazole alone. Symptoms, particularly pruritis resolved more rapidly, and there was a higher "cure" rate at the end of one and two weeks. 1% Hydrocortisone alone should never be used on tinea cruris in the tropics. Ten of 33 subjects suffered marked exacerbation, and 21 of the remaining 23 failed to respond to therapy.

Gris-PEG vs. microsize griseofulvin in tinea pedis.

10th Brigade Colombian Army. Clinical Study.

Ninety-five soldiers with athlete's foot (tinea pedis) received either 500mg Gris-PEG, 1000 mg. of a microsize griseofulvin preparation, or placebo daily under double-blind conditions. After four weeks on this regimen, both griseofulvin groups had improved more than the placebo patients. Despite the difference in dosage, the results in the two griseofulvin groups showed no statistically significant differences. Mild or moderate side effects occurred in five patients, one receiving Gris- PEG, two receiving microsize griseofulvin, and two receiving placebo.

Results: Both the group treated with Gris-PEG (250 mg. twice daily) and the group treated with microsize griseofulvin (500 mg twice daily) exhibited significantly greater improvement than did the patients receiving placebo. There was no significant difference between the Gris-PEG and microsize griseofulvin treated groups in terms of clinical efficacy.

The results of efficacy described below occurred even though the medications were administered to the patients while they continued to participate in the training program at their army field camp. No attempts were made to institute local hygienic measures in treating the athlete's foot. With private patients in civilian life, both oral antifungal therapy and such local treatment would likely be employed.

The overall clinical evaluation showed that after four weeks the following percentages of patients had improved.

Table 6.

	Gris-PEG (n=26)	Microsize griseofulvin (n=20)	Placebo (n=49)
Marked improvement	23%	20%	8%
Moderate improvement	27%	20%	12%
Slight improvement	27%	15%	14%
No improvement	23%	45%	66%

As a sidelight to the overall clinical evaluation, two weeks after the initiation of therapy, the lesions among the Gris-PEG treated patients, but not the microsize griseofulvin treated patients, had already significantly improved as compared to the patients receiving placebo.

The changes recorded in photographs were evaluated independently by the chief investigators and their assistants, with remarkably similar scores for any given

pair of before and after photographs, indicating that this was a valid method for measuring the patients' progress. This method showed the following kinds of improvement, again given in percentages of patients.

Table 7.

	Gris-PEG (n=26)	Microsize griseofulvin (n=20)	Placebo (n=48)
good/excellent	27%	20%	4%
fair	19%	20%	8%
poor	8%	5%	6%
no change	46%	50%	69%
worsened	0	5%	13%

BACTERIAL INFECTIONS - EPIDEMIOLOGY

Streptococcal pyoderma.

Colombia 1972.

Interest in group A Streptococcus pyogenes as a cause of common infections of the skin has escalated in recent years due to the increasing awareness of the relationship of dermophylic or "skin strains" of streptococci to AGN, and the development of more sophisticated methods of laboratory typing.

Most of the reports of epidemics of AGN have come from the tropics and neotropics, with the notable exceptions of the extensive work of Wannamaker and his colleagues in the Red Lake Indian Reservation in Minnesota, and the detailed reports from Dr. Hugh Dillon in Alabama.

Streptococcal infections would seem to be more prevalent in the tropics, but the role of climate and hygiene has not to our knowledge been critically studied by the same team using standardized methods under different climates.

The lack of accurate prevalence data, differences in bacteriological isolation techniques, socioeconomic and ethnic differences in populations studied and climatic variations make it difficult to compare the many different published surveys or to separate the effects within a population of different levels of hygiene and living conditions. We have, therefore, attempted to eliminate some of these variables by a survey of pyoderma in three populations of children in which levels of hygiene, ethnic background, sex, and climatological environmental stresses were defined using standardized clinical criteria and bacteriological methods.

Colombia appeared ideal for such an approach because of the diversity of climate and terrain within short distances, relative ethnic homogenity, and sizable underprivileged populations in which a high prevalence of infection might be expected, and a high degree of cooperation from our professional colleagues and government agencies in Colombia. Military as well as civilian populations were available for study. The Colombian Army is organized similarly to that of the United States and is kept in a constant state of operational readiness combating a chronic but active insurgency in terrain possibly more rugged and forbidding than that of Southeast Asia. Commanders were extremely receptive to the conduct of medical research in their units.

* Department of Dermatology, University of Miami School of Medicine, Florida
** Preventive Medicine Division, Walter Reed Army Institute of Research, Washington, DC

The four areas visited provided a wide range of altitude and climate, with consequent variation in living habits, vegetation, and insect life. Locations are indicated on the accompanying map. A capsule summary of the principal features of each location follows:

1) Bogota: a capital city; population 2.5 million; altitude 8,500 ft. (altiplano); ecologic zone (Holdridge's classification), dry-moist lower montane forest.

2) Medellin: second largest city; population 1.2 million; altitude 4,700 ft.; ecologic zone, moist subtropical forest.

3) Tolemaida: home of Tenth Brigade, Colombian Army; near town of Melgar in Magdalena River Valley; altitude 3,000 ft.; ecologic zone, dry tropical.

4) Apartado: frontier-type town carved out of jungle for commercial exploitation (bananas, cocoa, lumber); population ca. 5,000; at sea level near Gulf of Uraba; ecologic zone, moist tropical.

Methods

Total body examinations were made of all subjects in the study by the physician member of the team (AMA), and all skin defects which showed any evidence of infection were recorded on a body diagram sheet. After removal of crusts or debris, calcium alginate swabs (Colab) were used to inoculate exudate from each lesion on double layered Trypticase Soy Agar and 6% defibrinated sheep blood agar, 1 μg/ml Bacto (Difco) Crystal Violet was incorporated in each layer to selectively isolate β hemolytic streptococci. Staphylococcus aureus was isolated from lesions on nutrient agar (BBL) containing 4% actidione and 75μg/ml polymyxin B. Plates were incubated aerobically for 24 hours at 37°C, and negative plates were incubated for a further 24 hours. Fresh media was used throughout, refrigerated in storage before use, and transported to the field in insulated containers. Group A streptococci were identified by colonial morphology, hemolysis, and gram stains and bacitracin sensitivity, and S. aureus by colonial morphology, gram stains, and tube coagulase tests.

Evaluation of hygiene was made by a visual inspection of the children and their clothing, and visits to their homes and living quarters, inspection of the facilities of the institution under study, and discussions with teachers and supervisors. All populations were surveyed within a period of one month (September 1971).

Results

Surveys were performed for the primary purpose of determining the effect of climate on the prevalence and flora of bacterial pyoderma. Study populations were composed of children from the lower socioeconomic classes living in three climatic zones, cool, temperate, and tropical (all humid), and soldiers living in a humid tropical (jungle) or dry tropical (savanna) environment.

Table 8. Characteristics of Populations Surveyed
Pyoderma Survey: Colombia, September 1971

Location	Institution	Number Surveyed	Age Range	Age Median	Sex	Race	Hygiene
Bogota:	Redentor	133	5 - 19	12	M	Mixed	poor
	Sesquile	144	5 - 14	10	M+F	"	good
	Juan XXIII	65	2 - 7	4	M+F	"	fair
	Prado Pinzon	176	1 - 13	7	M+F	"	fair
Medellin:	Candelaria	31	4 - 11	9	F	"	fair
	Nina Maria	31	3 - 13	8	F	"	fair
	Recibo	109	5 - 17	12	M	"	poor
	Ciudad D.B.	115	6 - 18	12	M	"	good
	Posada	125	6 - 11	7	M+F	"	good
Apartado:	Esc. Ninas	91	5 - 15	10	F	"	fair
	Esc. Ninos	106	7 - 15	10	M	"	fair
	Finca	72	1 - 57	11	M+F	"	fair
	Lumber Co.	71	1 - 14	7	M+F	Negro	good

1269 children and 213 soldiers (total = 1482) were surveyed; 199 (12.6%) had pyoderma lesions which were cultured. Prevalence of pyoderma, and recovery of streptococci and staphylococci from lesions, varied according to climate. Prevalence and recovery rates were highest in the tropics. intermediate in the temperate zone, and lowest in the cool region (Table 9). Level of hygiene was another significant variable; within climatic zones differences in hygiene appeared to be the principal determinant of pyoderma prevalence (Figure 1).

Beta hemolytic streptococci were recovered from 82% of all lesions cultured, and from approximately 95% of anything purulent. Paired silica gel swabs (see last years report) cultured in Miami three to five weeks later gave similar results. Skin lesions which yielded streptococci included typical ecthyma, infected insect bites, erosive intertrigo behind the ears, infected lacerations, and impetigo of the scalp and face. It would not be far wrong to suggest that virtually any purulent lesion could be considered streptococcal.

PREVALENCE OF PYODERMA IN LOWER SOCIO-ECONOMIC CLASS COLOMBIAN CHILDREN ACCORDING TO ECOLOGIC ZONE (ALTITUDE AND CLIMATE) AND LEVEL OF HYGIENE

(TAPLIN & ALLEN, SEP 71)

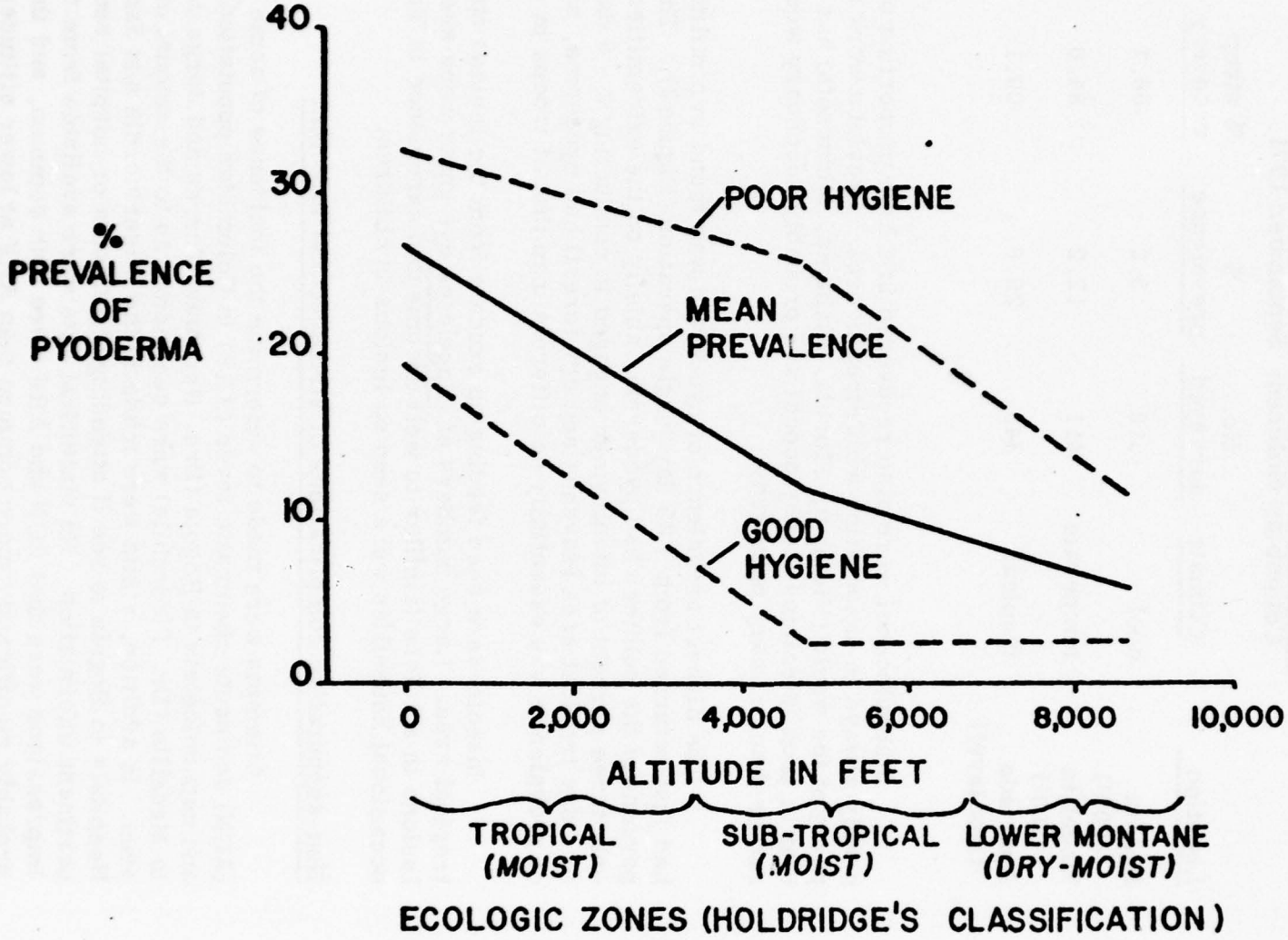


Fig. 1

Table 9. Prevalence of pyoderma, recovery of Streptococcus pyogenes and Staphylococcus aureus in relation to climate Colombian children: September 1971

Location	Climate	No. surveyed	% prevalence	% strep recovery	% staph recovery
Bogota (8500')	cool	518	5.2	66.7	51.8
Medellin (4700')	temperate	411	12.2	84.0	62.0
Apartado (sea level)	tropical	340	26.8	90.1	90.1

Staphylococci were also recovered in a high proportion of cases - 76% - nearly always in association with streptococci. Previous work in various parts of the world (Vietnam, Florida, Alabama, Minnesota) has indicated that in such infections staphylococci are probably secondary wound colonizers rather than primary pathogens.

The highest prevalence of pyoderma was found in a military unit which had just returned from a 25 day jungle operation (Figure 2). Thirty-eight percent of the soldiers had pyoderma, chiefly on the extremities. In contrast, only three percent of infantrymen engaged in conducting 2 - 3 day operations in a dry tropical area (savanna and dry forest) had pyoderma, and this level of prevalence was essentially no different than that of troops in garrison.

Insects were seen feeding on exudate from the lesions only in the humid tropical area. Large numbers of Hippelates eye gnats were seen feeding on lesions in soldiers (similar to well documented experience in Trinidad), and occasional houseflies were seen on lesions in children.

Non-suppurative complications of streptococcal infection

Attempts were made to determine the incidence of acute glomerulonephritis (AGN) and acute rheumatic fever (ARF) in Colombian populations. Pediatricians and nephrologists in Bogota (Drs. Hernando Torres and Jorge de la Cruz) and in Medellin (Dr. Piedrahila) were questioned as to the amount of each disease seen. In addition, visits were made to the Misericordia and San Juan de Dios Hospitals in Bogota to see if attending physicians or hospital records contained pertinent information. No statistical data were available from these sources. Impressions were that AGN and ARF were both common, and that AGN was probably significantly more common than ARF at lower altitudes (warmer climates) in Colombia.

PREVALENCE OF PYODERMA IN THREE COLOMBIAN ARMY UNITS

(TAPLIN & ALLEN, SEP 71)

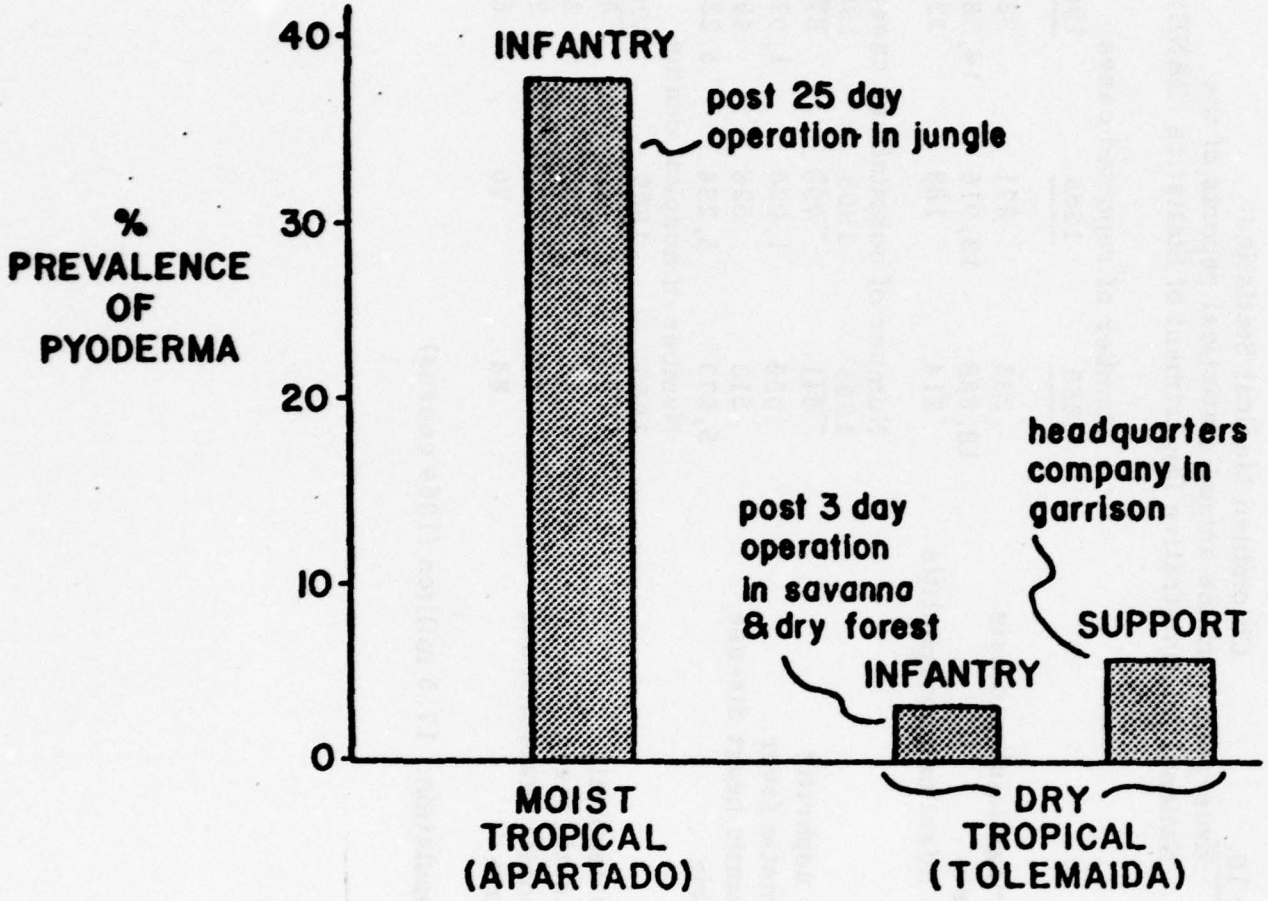


Fig. 2

National data from official sources indicates that AGN and ARF are almost equally common (Table 10). The limitations of these data preclude valid inferences concerning the impact of streptococcal infection on the Colombian people.

Table 10. Colombian Medical Statistics
Excerpted from the annual statistical reports of the National Administrative Department of Statistics (DANE)

	Number of reported cases		
	1965	1966	1967
American leishmaniasis	235	271	329
malaria	18,888	13,916	14,386
acute infectious encephalitis	214	188	525
	Number of hospitalized cases		
	1965	1966	1967
acute nephritis	541	790	872
rheumatic fever	955	1,026	1,070
rheumatic heart disease	513	526	480
malaria	5,973	5,294	5,230
	Number of hospital deaths		
	1965	1966	1967
acute nephritis	29	70	82
rheumatic fever	36	32	26
rheumatic heart disease	64	70	34
malaria	88	70	86

population: 17.5 million (1964 census)

Discussion

We believe this study to be unique in several respects. Due to the excellent cooperation of our Colombian hosts, we were able to work with populations in which the population at risk could be accurately defined. In the civilian and military groups, we were able to account for all individuals at risk, so that our data represents true prevalence of disease.

The evaluation of hygiene was established at the time the subjects were examined, without knowledge of the culture results. Each member of the team performed the same duties in each location, and the laboratory work was also conducted by the same individuals throughout. The same batches of media were used for all cultures. We, therefore, believe that the differences observed in the populations represent the effects of climate and hygiene.

The fact that we found a higher prevalence of clinical pyoderma in the hot moist environment at Apartado was not surprising. We surmise that this reflects the greater incidence of insect bites and perhaps the presence of wound feeding flies which were not present at the higher altitudes.

We were surprised by the higher recovery rates of both S. pyogenes and S. aureus (Table 9) from lesions in the hotter climate. At present we have no explanation for this. Our bacteriological methods were identical and the plates were incubated at 37°C throughout the study. It would seem that these pathogens are more abundant in lesions in the hotter climates, or for some reason are more easily recovered.

The most rewarding aspect of our findings were the almost linear relationship between prevalence of clinical disease and altitude (environmental temperature) and the obvious effect of hygiene at all altitudes. It is clear that this kind of data would be important in terms of health care planning or preventive medicine. For example, it would seem likely that the most effective method for the prevention of skin infections among children living at 5,000 feet in Colombia would be improvement of hygiene, which in practical terms means the provision of running water and soap in the homes or schools, whereas in the hotter regions it would probably require a more aggressive approach which would combine improved hygiene with early treatment of infections.

The experience with the Colombian Army units was remarkably similar to our findings in Vietnam. Men exposed to combat conditions, insect bites, and trauma in the tropics are likely to develop pyoderma and the pathogen is likely to be Streptococcus pyogenes.

We are still puzzled by the question of origin of these streptococci. We cannot recover them from normal skin in a healthy population, although we have recovered them from the perineum, nares and fingernails in about 25% of men who had active lesions in Vietnam.

Our studies in Vietnam, Florida, Haiti, Uganda and the tropical areas of Colombia are consistent in the high recovery of group A streptococci from purulent skin lesions. Over 90% of the lesions yield this pathogen, which would indicate a very high efficiency of colonization. This degree of infectivity in the absence of a detectable carrier state on the host is difficult to explain except on the basis of highly efficient insect vectors or a common and hitherto undiscovered environmental reservoir such as soil.

Summary

Studies on skin infections in Colombia, S.A., were performed in order to: 1) determine the effect of climate on the prevalence and flora of bacterial pyoderma, and 2) to acquire first-hand information concerning cutaneous infections of military importance in tropical Latin America. Surveys included nearly 1500 people (children and soldiers) living in four ecologic zones, ranging from the cool climate of Bogota to a jungle environment. Prevalence of pyoderma and rates of recovery of bacterial pathogens were highest in the jungle, intermediate in the temperate zone, and lowest in the cool climate. The level of hygiene was the principal determinant of prevalence within each climatic zone. S. pyogenes was recovered from 82% of all lesions cultured; S. aureus from 76%. Soldiers in the jungle had the highest prevalence of pyoderma - 38%. Soldiers in the dry tropics (savanna) had a low prevalence of pyoderma.

Acknowledgements

We wish to thank Colonel Edward Buescher, MC, Director of WRAIR, and LTC Taras Nowosiwsky, MC, Chief, Preventive Medicine Division, WRAIR for their prompt response to our request for the participation of an in-service epidemiologist/physician (LTC Allen) in this project.

We owe much to our generous hosts in Colombia: Dr. Guillermo Arboleda, Dr. Gonzalo Calle, Dr. Alonso Cortes, Col. Dr. Hernando Latorre, Dr. Fabio Londono, Miss Amparo Motta, Major Padilla, Dra. Angela Restrepo, and Dr. Rafael Rodriguez.

Yavisa, Panama. 1972.

In February 1972, we received a request from Preventive Medicine Division, Walter Reed Army Institute of Research, to provide logistical and laboratory support to a military field team during a survey of skin problems in the Darien Province (Yavisa and El Commun) in the Republic of Panama. This provided us with an opportunity to test the feasibility of preparing a portable laboratory, media and instruction manual for a field team in which we were not involved, and handle the cultures from the team at the completion of the study as a function of our extramural contract program. The experience gained from this project indicates that the system offers an effective way of putting a military team into the field at short notice without the time consuming and cumbersome requirements of gathering together all the equipment and supplies, most of which are non-standard or as in this case newly developed techniques which are not available commercially.

Should such support be needed in the future, the only action required by the agency requesting assistance is to provide us with the following information:

1) estimated population at risk,
2) location,
3) disease or pathogens to be studied.

Under normal circumstances we can arrive at a reasonable estimate of conditions to be encountered, and pack a portable laboratory within one week of receiving the request.

In addition, we can supply or make arrangements for communications, photography, tape recording, local contacts in the civilian scientific community, field rations and couriers.

For the study described here, the team was equipped to study superficial and deep mycoses, bacterial pyodermas, including cutaneous diphtheria, cutaneous leishmaniasis, and a 24 hour availability of a courier to deliver additional supplies in the event of unexpected findings. They were also supplied

microscopes, biopsy and minor surgery kits, tape recorder, climatological measuring equipment, insect traps, body diagram sheets, secretarial supplies, lyophilized rations, cooking equipment and stove and survival kits, and a kit to convert a beer cooler to field incubator.

All media was prepared for use or supplied as preweighed kits. Although the team was out of contact with us in Yavisa, telephone communication between the laboratory at MARU in the Canal Zone and our laboratory in Miami was rapid and reliable.

The results of this study are included here as a reprint from the American Journal of Tropical Medicine and Hygiene, September 1974.

THE AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE
Vol. 24, No. 5
Printed in U.S.A.
pp. 950-956

SKIN INFECTIONS IN EASTERN PANAMA

SURVEY OF TWO REPRESENTATIVE COMMUNITIES*

ALFRED M. ALLEN† AND DAVID TAPLIN

Division of Preventive Medicine, Walter Reed Army Institute of Research, Washington, D.C. 20012, and Departments of Dermatology and of Epidemiology and Public Health, University of Miami School of Medicine, Miami, Florida 33124

Abstract. A skin infection survey of 1,084 people was carried out in two jungle villages in eastern Panama. Bacterial pyoderma was the most prevalent infection, affecting 25% of boys, 15% of girls, and 11% of those over 10 years of age. *Streptococcus pyogenes* and *Staphylococcus aureus* were recovered from 84% of pyodermas cultured. Nearly 60% of the cutaneous staphylococcal isolates were resistant to penicillin. *Hippelates* flies were seen feeding on purulent skin lesions and may have been important in transmission. Scabies, ringworm, candidiasis, and cutaneous leishmaniasis were rare in comparison with pyoderma, involving less than 1% of the population each. All of the ringworm infections were caused by *Trichophyton rubrum*.

Skin infections are an important clinical and public health problem in tropical areas of the world. In hot, humid climates, a third of the school children may have streptococcal pyoderma at any given time, and other cutaneous infections and infestations may be highly prevalent as well.[1] These infections are uncomfortable and unsightly, and can lead to serious complications, including spreading cellulitis, chronic skin ulcers, and acute glomerulonephritis [A.G.N.].[2] Among military personnel in the tropics, skin infections are a leading cause of outpatient visits, hospitalization, and temporary disability.[3]

Despite the importance of these infections, little is known about their epidemiology in tropical populations. Published information is largely limited to reports of epidemics and statistics derived from selected clinic populations.[1, 4] Consequently, there are almost no community-based data that might be used for developing effective preventive measures, planning health care delivery, or assigning research priorities.

In April 1972 we conducted a survey in two villages in eastern Panama to determine the etiology, prevalence, and other characteristics of skin infections among native populations in a jungle environment. Among the reasons for selecting eastern Panama for survey is the growing interest in potential health hazards to workers who will construct the proposed sea level canal and complete the Interamerican Highway.[5]

Accepted 9 February 1974.

* This work was supported in part by the U.S. Army Medical Research and Development Command under research contract DADA 17-71-C-1084.

† Present address: Letterman Army Institute of Research, Presidio of San Francisco, California 94129.

MATERIALS AND METHODS

Location. Surveys were carried out in two remote jungle communities, Yaviza and El Comun, located in Darien Province, Republic of Panama. Their relationship to population centers and the future route of the Interamerican Highway is shown in Figure 1. Two candidate routes for the proposed sea level canal lie within 70 km northwest and southeast of Yaviza.[6]

Environment. Yaviza and El Comun lie at sea level along tidal rivers in the dry-moist tropical ecologic zone (Holdridge's classification).[6] The mean daily temperature is nearly constant year round at 28° C and the mean relative humidity is 83%. The rainy season occurs from mid-April (the time of the survey) to mid-December. The predominant vegetation is multi-canopied jungle.

Populations. The inhabitants of Yaviza are largely of black African origin. An estimated 1,730 people reside there, of whom about one-third are usually not present at any given time (Daniel C. Warren and Robert J. Chloupek, Division of Preventive Medicine, Walter Reed Army Institute of Research, Washington, D.C. 20012. Unpublished data). The town is a minor commercial center and its economy is based on bananas, plantain, lumber, and subsistence agriculture.

El Comun is a Choco Indian village of 131 permanent inhabitants. The Indians are primitive

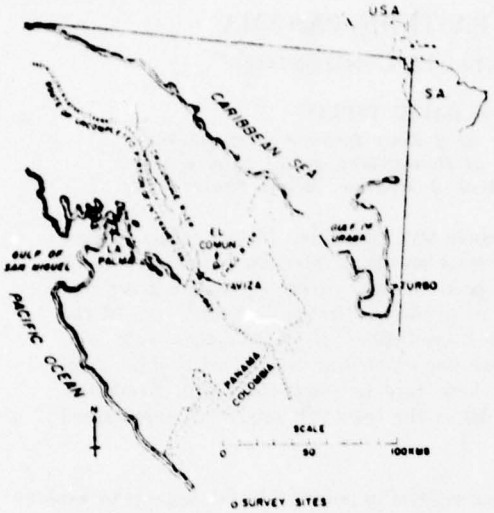


FIGURE 1. Map of eastern Panama showing the location of the villages surveyed.

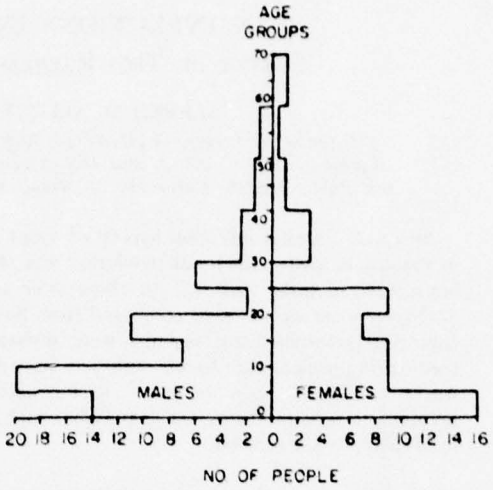


FIGURE 3. Population pyramid of El Comun, showing the population examined in the skin infection survey.

and rely primarily on food gathering for subsistence. The residents of El Comun differ from those in Yaviza in culture, dress, and occupation, but similar low levels of sanitation and hygiene prevail in both places. There is no running water and defecation takes place in outdoor privies or on the ground. Intestinal parasitism and nutritional anemia are extremely common in both populations (John W. Cutting, Daniel C. Warren, and Robert J. Chloupek, Division of Preventive Medicine, Walter Reed Army Institute of Research, Washington, D. C. 20012. Unpublished data).

Surveys. An attempt was made to examine the entire population of each community. Surveys were conducted in central areas and all residents were strongly urged to participate. In Yaviza, 892 (52%) of the total estimated population of 1,730 participated in the survey. The response rate was 79% if the focus is restricted to the 1,130 people present in the town while the survey was being conducted. The age and sex composition of the survey population is compared to that of the total estimated population in Figure 2. In El Comun, all of the inhabitants participated in the survey. The age and sex composition of the El Comun population is shown in Figure 3.

Clinical and microbiological examination. The entire skin surface of each subject was examined

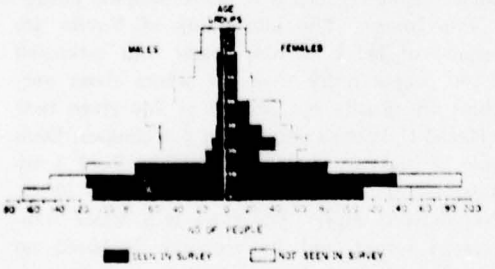


FIGURE 2. Population pyramid of Yaviza, showing the total population (large pyramid) and the population examined in the skin infection survey (small pyramid).

TABLE 1

Prevalence of skin infections and infestations in a survey of 1,084 people in eastern Panama

Diagnosis	No. cases	Prevalence (%)
Pyoderma	160	14.8
Scabies	7	0.6
Papular urticaria	7	0.6
Dermatophytosis	5	0.5
Cutaneous candidiasis*	2	0.2
Chromomycosis	1	0.1
Hidradenitis suppurativa	1	0.1
Perianal abscess	1	0.1
Flea bites	1	0.1
TOTAL	186	17.2

* Excludes candidal paronychia.

TABLE 2

Age and sex-specific prevalence of pyoderma in residents of Yaviza

Age (years)	Males		Females		Total		Ratio of male to female rate
	No. surveyed	Prevalence (%)	No. surveyed	Prevalence (%)	No. surveyed	Prevalence (%)	
0–4	109	22.0	111	15.2	220	18.6	1.4
5–9	115	25.2	137	14.6	252	19.4	1.7
10–14	74	14.9	82	12.2	156	13.4	1.2
15+	83	15.7	181	6.1	264	9.1	2.6
TOTAL	381	20.2	511	11.3	892	15.2	1.8

by a single observer (A.M.A.) and all skin lesions showing clinical evidence of infection were recorded on a body diagram sheet. One skin lesion of each type (e.g. pyoderma or ringworm) was selected for culture.

Material for bacterial culture was collected on sterile calcium alginate swabs and 1) plated immediately on a selective medium of nutrient agar containing 400 μg/ml cycloheximide and 75 μg/ml polymyxin B for staphylococci,[7] and 2) desiccated in individual silica gel packs and plated in Miami 2 to 3 weeks later on trypticase soy agar containing 1 μg/ml crystal violet and 6% sheep's blood for streptococci.[8] Plates were incubated aerobically at 37° C for 48 hours. Group A streptococci were identified by colonial morphology, hemolysis, and bacitracin sensitivity. *Staphylococcus aureus* was identified by colonial morphology and tube coagulase tests. Antibiotic sensitivities were determined by the Kirby-Bauer disc method.[9]

Scrapings for fungal culture were inoculated onto DTM,[10] incubated at room temperature, and results evaluated within 14 days. Yeasts were differentiated by the germ tube test.

The indirect fluorescent antibody test for cutaneous leishmaniasis was performed according to the method of Walton et al.[11] Cultures for leptomonad forms of leishmania were performed by inoculation of tissue fluid obtained from the margins of the lesion onto 15% rabbit's blood agar slants and incubated at 25° C for 72 hours.

RESULTS

Three populations were included in the survey: 1) 892 residents of Yaviza; 2) 40 Choco Indians transient in Yaviza; and 3) the 131 Choco Indian inhabitants of El Comun. In Yaviza, this represented 97% of the children (0–14 years), 74% of the women (≥15 years), and 37% of the men (≥15 years) who were present in the town. In all, 1,084 people were surveyed.

The prevalence of each of the 10 types of skin infection or infestation found in the combined survey populations is shown in Table 1. Skin infections other than pyoderma were found only in residents of Yaviza. Tropical phagedenic ulcer and classical eschar-forming cutaneous diphtheria were not seen.

Bacterial infections

Bacterial pyoderma was more than six times as common as all other skin infections and infestations combined (Table 1). The crude prevalence rates for pyoderma were similar in each of the three populations surveyed: In Yaviza the prevalence was 15% (135/892); in transient Indians it was 13% (8/40); and in El Comun it was 13% (17/31).

Age and sex-specific prevalence rates were calculated for the survey population of Yaviza (Table 2). Pyoderma was found to be approximately twice as common in children as in adults, and more common in males than females at every age.

FIGURE 4. A. Multipustular impetigo in a 2-year-old girl. Lesions cleared within 3 days after administration of benzathine penicillin G. B. *Trichophyton rubrum* infection in a 25-year-old man. Lesions covered ire body, including the palms. C. Severe scabies with early secondary infection by streptococci. D. omycosis in an elderly woman. Similar lesions were present on the leg and trunk. E. Cutaneous can- in a 2-year-old boy. F. Cutaneous leishmaniasis on the upper arm of a lumberman. The lesion was ly tender.


A
B
D
E

TABLE 3

Age-specific rates of recovery of bacterial pathogens from pyoderma in residents of Yaviza

Age (years)	No. cultured	Percent positive	
		Streptococcus pyogenes	*Staphylococcus aureus*
0–4	41	87.7	95.2
5–9	49	73.5	85.8
10–14	21	61.9	80.9
15+	24	91.7	75.0
TOTAL	135	79.3	86.7

Clinically, pyoderma appeared in many forms, including ecthyma, infected insect bites, erosive intertrigo behind the ears, infected lacerations, and crusted impetigo of the face and ears. More than 90% of the lesions were located on the face or on the extremities. Two infants had extensive multipustular impetigo involving the face and neck (Fig. 4A).

Of the 160 persons with pyoderma, 133 (83%) were positive for β-hemolytic streptococci (*Streptococcus pyogenes*) and 135 (84%) were positive for *Staphylococcus aureus*. Most of the streptococcal isolates (118, or 89%) belonged to Group A; the remaining 15 isolates were not individually grouped. Rates of recovery of bacterial pathogens were similar in each of the three survey populations.

There was a correlation between age of cases and rates of recovery of both streptococci and staphylococci. With the exception of males aged 15 and over, the proportion of cases yielding these pathogens showed a progressive decrease with age (Table 3). The high rate of recovery of streptococci from men appears to have been due to a tendency for those with more severe infections to participate in the survey proportionately more frequently than those with milder infections.

Streptococcal and staphylococcal isolates were tested for sensitivity to the following antibiotics: penicillin (2 and 10 μg), erythromycin, tetracycline, chloramphenicol, cloxacillin, lincomycin, and gentamicin. All of the Group A streptococci were sensitive to these antibiotics. Five of the 15 non-Group A isolates (33%) were resistant to tetracycline, but all were sensitive to the other six antibiotics. Of the 126 staphylococcal isolates tested, 73 (58%) were resistant to penicillin, 4 (3%) were resistant to tetracycline, and 3 (2%) were resistant to chloramphenicol. All staphylococcal isolates were sensitive to erythromycin, cloxacillin, lincomycin, and gentamicin.

Fungal infections

Body ringworm infections (tinea corporis) were present in five adult residents of Yaviza, of whom four were men. All of the infections were caused by *Trichophyton rubrum*. Isolates from two of the cases were unusual in that their morphology on initial culture was identical to that of a distinctive variant ordinarily found only in the South Pacific. One of these isolates was recovered from an extensive infection that covered the entire body of an otherwise healthy-appearing 25-year-old man (Fig. 4B).

Scalp ringworm (tinea capitis) was not found in any of the 550 prepubertal children examined. Thirty-nine children (7%) had crusted, dry, scaling lesions bearing a superficial resemblance to tinea capitis, but close inspection revealed no evidence of broken hairs or fungal growths on hair shafts, and all were negative on fungal culture. Possibly these lesions represented a variant of pyoderma, since five children with crusted scalp lesions had associated pyoderma, of which two yielded streptococci and four yielded staphylococci.

Two infants in Yaviza had inflammatory maculo-papular eruptions, with satellite papules, involving the neck, back, and upper chest. Both were positive for *Candida albicans* (Fig. 4E).

Approximately one-quarter of the women in Yaviza had chronic, moderately symptomatic candidal paronychia of the fingers. No attempt was made at culture.

An advanced case of chromomycosis with yellow, fungating cauliflower-like masses protruding from one leg was seen in an elderly woman (Fig. 4D).

Parasitic infections and infestations

Cutaneous leishmaniasis was seen in a 26-year-old lumberman who worked in the jungle. He had a 10 × 10 cm, painful, deeply ulcerating lesion present for three weeks on the upper arm (Fig. 4F). Cultures of tissue fluid from the margins of the lesion were positive for leptomonad forms and the indirect fluorescent antibody test was positive at a 1:128 dilution. A biopsy showed a histologic reaction consistent with leishmaniasis, but no organisms were seen on a Giemsa-stained

section. The infection responded to pentavalent antimonial (Glucantime®) therapy.

Five adult residents of Yaviza had smooth, round, 3 × 3 cm scars on the extremities that were compatible with healed leishmaniasis. All had recently migrated from an endemic area of Colombia.

DISCUSSION

This survey and others that we have conducted in Southeast Asia,[12] Africa,[13] and South America[14] have led us to certain conclusions concerning the relative frequency of various types of skin infections in tropical populations. It appears that exotic "tropical" skin infections, such as cutaneous leishmaniasis and tropical ulcer, are rare in the tropics, whereas less spectacular infections, such as streptococcal pyoderma, are usually prevalent to a degree that would be considered epidemic in the United States and other northern countries. These conclusions are supported by the findings of others[1, 15] who have reported on the relative prevalence of cutaneous infections in tropical areas where poor hygiene, anemia, and intestinal parasitism are endemic. They are also in agreement with the opinion expressed by Verhagen et al.[4] that the exotic and unusual have been overstressed in reviews of skin diseases in tropical countries; and that this has been done at the expense of more common conditions which individually are not as serious, but which collectively may be more important.

The rates of recovery of streptococci and staphylococci from pyoderma were in agreement with those found worldwide,[1, 2, 12-14] but the apparent correlation between age of cases and rates of recovery has not been previously reported. This may represent increasing resistance to infection with increasing age, as suggested by a previous study of pyoderma.[12]

The simultaneous recovery of both streptococci and staphylococci from a single skin lesion has led to a great deal of controversy in the past, but recent evidence indicates that in most instances streptococci are the primary pathogens while staphylococci are secondary wound colonizers.[12, 14] Penicillin has been found effective in treatment despite the presence of penicillin-resistant staphylococci in the lesions.[17]

Antibiotics were seldom used in the populations we studied in Panama, and it was no surprise that almost none of the staphylococcal and streptococcal isolates were resistant to six antibiotics commonly prescribed in the United States. This situation was different than that which we have encountered in other tropical countries, such as Vietnam, where antibiotics are in common use and high proportions of staphylococci and streptococci isolated from the skin are resistant to tetracycline.[12] We have no ready explanation for the fact that nearly 60% of the cutaneous staphylococcal isolates from eastern Panama were resistant to penicillin, although it is perhaps possible that this may reflect the influence of nonmedicinal (i.e., naturally occurring) penicillin in the environment.[18]

When examining people with pyoderma, it was common to observe swarms of small flies of the genus *Hippelates* feeding on secretions from the lesions. *Hippelates* flies have been implicated in the transmission of pathogenic bacteria and may be important as vectors of streptococcal pyoderma.[19, 20]

We did not examine children for evidence of subclinical acute glomerulonephritis (A.G.N.), nor did we serologically type the streptococcal isolates to determine whether nephritogenic M-types were present. We did check for clinically overt A.G.N. and found no indications that it existed either in the survey population or among patients in the local health center.

The age and sex-specific prevalences of pyoderma in Panama did not conform to the patterns usually described,[2] but differed in that infections were equally as common in older children as in pre-schoolers and were distinctively more common in males than in females. These findings suggest that the epidemiology of pyoderma in the tropics may differ from that in temperate areas of the world.

Even within the same tropical environment, the type of population at risk may be the principal determinant of the frequency of skin infections. Surveys of 97 U. S. Army personnel who spent 3 months in a similar area of Panama under dirty field conditions revealed a high incidence of fungal skin infection, particularly in the groin area.[20] Six weeks after arrival in Panama, the prevalence of culture-confirmed tinea cruris was 11%, while that of crural candidiasis was 45%. These findings stand in marked contrast to our findings in Yaviza and El Comun, where none of

the 114 men surveyed had fungal infections of the groin. The reasons for these host-related differences are not clear and would seem to warrant further investigation.

ACKNOWLEDGMENTS

We wish to thank Dr. Dennis R. Swanson, Dr. Pablo Othon, Mr. Gaston Bernal, and Mr. Ignacio Bocanegra for assistance in organizing and conducting the survey; and Ms. Lyle Lansdell and Ms. Irma de Arjona for performing in-vitro laboratory studies.

REFERENCES

1. Svartman, M., Potter, E. V., Finklea, J. F., Poon-King, T., and Earle, D. P., 1972. Epidemic scabies and acute glomerulonephritis in Trinidad. *Lancet, 1:* 249–251.
2. Wannamaker, L. W., 1970. Differences between streptococcal infections of the throat and of the skin. *N. Engl. J. Med., 282:* 23–30; 78–85.
3. Allen, A. M., Taplin, D., Lowy, J. A., and Twigg, L., 1972. Skin infections in Vietnam. *Milit. Med., 137:* 295–301.
4. Verhagen, A. R. H. B., Koten, J. W., Chaddah, V. K., and Patel, R. I., 1968. Skin diseases in Kenya. A clinical and histopathological study of 3,168 patients. *Arch. Dermatol., 98:* 577–586.
5. Stacy, H. G., Young, M. D., and Fairchild, G. B., 1973. A survey to assess potential human disease hazards along proposed sea level canal routes in Panama and Colombia. I. Introduction. *Milit. Med., 138:* 269–270.
6. Eldridge, B. F., and Fairchild, G. B., 1973. A survey to assess potential human disease hazards along proposed sea level canal routes in Panama and Colombia. II. Geography of proposed routes. *Milit. Med., 138:* 271–275.
7. Finegold, S. M., and Sweeney, E. E., 1961. New selective and differential medium for coagulase-positive staphylococci allowing rapid growth and strain differentiation. *J. Bacteriol., 81:* 635–641.
8. Cruickshank, R., 1965. *Medical Microbiology,* 11th ed. The Williams & Wilkins Co., Baltimore.
9. Bauer, A. W., Kirby, W. M. M., Sherris, J. C., and Turck, M., 1966. Antibiotic susceptibility testing by a standardized single disk method. *Am. J. Clin. Pathol., 45:* 493–496.
10. Taplin, D., Zaias, N., Rebell, G., and Blank, H., 1969. Isolation and recognition of dermatophytes on a new medium (DTM). *Arch. Dermatol., 99:* 203–209.
11. Walton, B. C., Brooks, W. H., and Arjona, I., 1972. Serodiagnosis of American leishmaniasis by indirect fluorescent antibody test. *Am. J. Trop. Med. Hyg., 21:* 296–299.
12. Allen, A. M., Taplin, D., and Twigg, L., 1971. Cutaneous streptococcal infections in Vietnam. *Arch. Dermatol., 104:* 271–280.
13. Nsanzumuhire, H., Taplin, D., and Lansdell, L., 1972. Pyoderma among Ugandan children. *East Afr. Med. J., 49:* 84–88.
14. Taplin, D., Lansdell, L., Allen, A. M., Rodriguez, R., and Cortes, A., 1973. Prevalence of streptococcal pyoderma in relation to climate and hygiene. *Lancet, 1:* 501–503.
15. Buck, A. A., Sasaki, T. T., and Anderson, R. I., 1968. *Health and Disease in Four Peruvian Villages: Contrasts in Epidemiology.* Johns Hopkins Press, Baltimore, pp. 97–99.
16. Dillon, H. C., Jr., 1968. Impetigo contagiosa: Suppurative and non-suppurative complications: I. Clinical, bacteriological, and epidemiologic characteristics of impetigo. *Am. J. Dis. Child., 115:* 530–541.
17. Dillon, H. C., Jr., 1970. The treatment of streptococcal skin infections. *J. Pediatr., 76:* 676–684.
18. Smith, J. M. B., and Marples, M. J., 1965. Dermatophyte lesions in the hedgehog as a reservoir of penicillin-resistant staphylococci. *J. Hyg. (Camb.), 63:* 293–303.
19. Bassett, D. C. J., 1970. *Hippelates* flies and streptococcal skin infections in Trinidad. *Trans. R. Soc. Trop. Med. Hyg., 64:* 138–147.
20. Taplin, D., Zaias, N., and Rebell, G., 1967. Skin infections in a military population. *Devel. Indust. Microbiol., 8:* 3–12.

Costa Rica. 1975.

> "Through direct observation of health and disease in nature, the aim is to identify varying distributions of a condition, in place and in time, and according to characteristics of the people affected, with the objective to determine factors of man and of environment active in causation. It is the diagnostic instrument of mass disease. It rests on principles derived from Thoreau, that if one would learn about nature, it is necessary to go where it is . . . . An epidemiologic analysis leading to identification and assembly of those characteristics of man and environment contributing to the complex of causality is clearly the prime requisite to a programme for prevention and control of a community disease. Control operates on epidemiological facts."
>
> from "Ecologic Interplay of Man, Environment and Health", John E. Gordon, American Journal of Medical Sciences 252, September 1966.

The principles expressed by Dr. Gordon almost ten years ago represent the backbone of our field studies under this contract, and as we see it, our major contribution to the needs of the USA Medical R & D Command; that is to establish the epidemiological facts on which future control measures and research efforts may be based. This portion of the report concerns itself with our progress in translating these well-meaning phrases into actual productive work in the field.

In 1968 and 1969, the field epidemiologic team under Captain (now Col.) Alfred M. Allen was provided with a sophisticated laboratory facility without which this productive period of USAMR & D sponsored research would not have been possible. The many techniques and experience developed under this contract contributed much to the success of this team, but it still required a base laboratory in the field to support the team in microbiologic capabilities. Since 1969, we have attempted to continue our programme in field epidemiology in Uganda, Colombia, Venezuela and Nigeria. In each of these countries we were provided facilities and laboratory space by the University centers in Kampala, Bogota, Caracas and Lagos. Although our hosts were hospitable and generous, the projects were often in jeopardy because of seemingly small problems which arise under the stress and time considerations imposed by handling hundreds or sometimes thousands of culture isolates. In large scale mobile epidemiology studies, efficiency in media preparation, handling of cultures on a daily basis and preparing them for safe shipment back to the United States becomes of paramount importance, and all of this must be accomplished while finding relatively safe food and water for the field team, arranging schedules for the population studies, finding sleeping accommodations and taking care of the many liason and logistical problems.

Much of what we take for granted in our home laboratories (incubation space at the correct temperature, glassware, disposable petri dishes, refrigerator storage and electricity 24 hours a day) were often not available in the area of operations. We, therefore, conceived the idea of a self-contained mobile epidemiology laboratory and living facility for a field team, able to go anywhere in the world to conduct surveys, maintain the health and comfort of the team, and be able to handle the intake of specimens on a daily basis. We were concerned with the total logistical problems of getting field teams into endemic and often remote areas and out again with the least encroachment on the limited resources of the host country and with maximum efficiency and welfare of the team. The following is a report of progress and our experience in Costa Rica.

Planning: In the early months of 1975, arrangements were made with the University of Costa Rica in San Jose to train a field team in Costa Rica and to begin epidemiologic surveys in areas which had not been previously evaluated. Appropriate permissions were obtained from the Ministry of Health, the University of Costa Rica, the College of Physicians and Surgeons and the Costa Rican Dermatologic Society. The team was to consist of senior microbiology students and physicians from the University of Costa Rica and the project was to be coordinated by David Taplin. The mobile facility consisted of a modified HI-LO trailer which collapsed for towing and shipping, but could be extended to full height when on station. The interior was equipped with 110 V and 12 V wiring and lighting, two work benches, double sink, toilet-shower, stowaway beds to sleep six, 110/12 V incubator, centrifuge, microscope and consumable supplies to conduct microbiology. Our hosts informed us that the project should get underway not later than June 1st, due to the encroachment of the rainy season and the likelyhood that some of the roads in remote areas might not be usable.

The trailer and Jeep Wagoneer were shipped from Miami to Puerto Limon in mid May, 1975, where we met the ship and drove the unit directly to the University of Costa Rica. The first week was spent in conferences and liason meetings with faculty members of the University, selecting students for the team, orientation lectures and planning. It was decided to make a preliminary run to two isolated villages, Naranjal and Cangrejal in the center of Costa Rica, which were highly endemic for cutaneous leishmaniasis. The students selected were about to graduate from a four year programme and were skilled in clinical microbiology, parasitology, immunology and mycology, but had little exposure to organized field epidemiology. Their faculty advisors were highly enthusiastic at the prospect of sending their best students into the field. With less than a week to prepare, five students were assigned a variety of projects to tackle, in addition to our primary objective of estimating the prevalence and etiology of skin infections. The projects selected for them included:

a) Collection of blood samples from cases of healed and active cutaneous leishmaniasis for later serological testing with an equal number of matched controls.

b) Evaluation of immediate and delayed skin test reactions to two antigen preparations from Leishmania braziliensis.

c) Trapping and collecting slugs (Vaginulus (Sarasinula) plebeius) and small rodents, the intermediate and definitive hosts of Angiostrongylus costaricensis.

d) Evaluating the prevalence and etiology by cultural methods of common skin infections, both bacterial and fungal.

Any one of these projects was worthy of a field study in itself, and considering the difficult roads, an untested mobile unit staffed by a newly formed team, and only a vague idea of the population distribution, it was unlikely that any of the projects would be completed in the seven to ten days we estimated we could remain on station. However, rather than introduce a negative approach, we tackled all of the tasks, believing that this would be the quickest and most effective way of gaining experience as a team. It was indeed a valuable lesson. The trailer was stationed in San Ignacio, and we proceeded to the villages of Cangrejal and Naranjal using the Jeep Wagoneer. The roads to these two villages consisted of 25 kilometers of narrow uneven cart tracks of red clay winding through mountainous terrain, which although navigable in the morning, became treacherous mud slides after the afternoon rains. We eventually resorted to packing supplies on a horse and walking the team in, but even this presented problems for man and horse in attempting to maintain a foothold on the steep inclines. After four days a bruised and exhausted team succeeded in culturing 12 cases of pyoderma, identified 11 cases of leishmaniasis, trapped one cotton rat and collected ten slugs. Landslides cut off our water supply in San Ignacio, and the water supply in the trailer became contaminated with transmission fluid when local boys who had climbed a mountain to bring us water in cans used the funnel from our tool kit to fill the on-board holding tank. In four days we wore out the disc brakes on the jeep, had problems with the lights and transmission and split the fuel tank, losing an entire day and night for repairs. In short, we spent more time solving mechanical and logistical problems than conducting field epidemiology, which was not likely to be meaningful in any case because the population at risk lived in isolated dwellings among the mountains rather than in two discrete "villages" as we had expected. Therefore, no estimate of prevalence of disease could be obtained because we had no denominators.

Thus, in the first week this fledgling team learned some valuable lessons:

a) A prior scouting expedition to the proposed target population is essential to evaluate road conditions, population distribution, and to arrange for a census or appropriate sampling technique if prevalence data is sought.

b) Tackling a variety of clinical problems dilutes the team effort and is likely to produce no worthwhile results from any one project.

c) Testing of hardware (e.g. the Jeep) must be conducted under conditions to be expected in the target area. While suitable for the flatlands of Florida, the rough mountain tracks in Costa Rica resulted in major mechanical

failures after only one week.

d) No essential functions (supply of drinking water for example) should be delegated to non-team members.

e) The basic laboratory field methods worked well.

f) The team could work in harmony under conditions of severe stress.

On returning to San Jose, meetings were held with the Dean of the School of Microbiology, other Faculty and the field team students. It was decided that the lessons learned in the first week were valuable, and that the team was now prepared to tackle a definitive single study related to skin infections. David Taplin was appointed team chief, and the field team was to consist of four students and a physician, with another physician to follow up cases in need of urgent medical care. In this way the field team could concentrate on epidemiology without ignoring the need of health care delivery, at least for the most deserving patients. Three objectives were selected:

1) To estimate the prevalence of skin diseases among school children in rural areas in relation to environment (altitude, climate, vegetation, insect vectors, agricultural practices, housing), age and sex.

2) To identify populations with significant problems to guide future allocation of medical personnel and funds, or areas where future clinical studies would be rewarding.

3) To test two methods (LAIR medium and MIAMI medium) for recovery and presumptive identification of Staphylococcus aureus from skin lesions under field conditions.

Background: Between Santa Ana, 20 kilometers west of San Jose and the town of Parrita on the Pacific coast of Costa Rica, there are 23 schools on or near the highway over a distance of approximately 140 km. None is more than 8 km from the next school and each has an enrollment of between 60 and 230 students, ranging in age from 7 to 16. These schools are situated at altitudes ranging from 1,100 M at Cerbetana to sea level at Parrita. All children are of similar ethnic derivation, and all populations in the study were rural. These schools, therefore, represented populations at risk living at altitudes which could be much more closely defined than in previous studies. Moreover, nothing was known concerning the relative frequency of skin diseases, nor their etiology.

Mindful of the lesson learned in the first field experience, Dr. Roger Bolaños and David Taplin made a preliminary visit to all 23 schools along the highway, interviewed the school principals and evaluated the logistical problems. From this trip it was immediately evident that there was no clear understanding of the prevalence of skin infections, except that the reports from higher elevations suggested that there were "very few" whereas in Parrita the teachers reported "a lot". We were also impressed with the myriads of Hippelates flies in Parrita which we had not encountered at the higher elevations. It was also apparent that the temperature at 100 M and only ten Km distant was sensibly lower than the sea level area of Parrita.

The situation appeared ideal for our studies, and nine representative rural schools between Puriscal and Parrita were selected for surveys. Be-

cause the highest prevalence and consequently, the greatest work load was likely to be found in Parrita, it was decided to drive the mobile unit directly there and to work back, thus taking advantage of a fresh rested team where working conditions would be most adverse. The team was reassembled, the trailer stocked with food and media, the Jeep repaired and we drove uneventfully to Parrita to begin the studies.

Methods: At each school, attendance was checked against enrollment and all children not in school at the time of the survey were accounted for and their reason for non-attendance recorded. All children were examined from head to toe by one observer (D. T.) and all skin lesions recorded on a body diagram sheet. A notation of clinical diagnosis and stage of disease were recorded at this time with instructions for the two microbiology stations, according to the following criteria:

Active pyoderma - culture (well circumscribed single lesion with pus, erythema and crust, obviously infected),
Healing pyoderma active - culture (obviously has been worse and now healing, but still clinically infected).
Healing pyoderma dry - no culture (still evident lesion, but not an old scar, no evidence of infection, dry intact epidermis, no crust).
Old scar - no culture (obviously was once a pyoderma, but now only residual superficial scar or hyperpigmentation).
Pyodermas active - take best one for culture (used for clusters of lesions or multiple lesions, most purulent or active selected).
Very early small - culture (any very small lesion not yet echthymatous, but looks infected, e.g. pustule, infected insect bite, etc.).
Infected abrasion - culture (any abrasion showing serous or purulent exudate with erythema).
Fresh abrasion not infected - no culture.
Old leishmaniasis scar - record origin (no active cases of leishmaniasis seen in this survey, all old scars were in children who once lived in endemic area).

Two microbiology stations were set up, each manned by two students using identical methods. Crusts were lifted to expose pus and healing lesions were gently knicked with a scalpel and squeezed to express underlying pus. Material was collected on two calcium alginate swabs; one was used to inoculate Trypticase Soy Agar with Sheep Blood (TSAB) and the same media containing 0.8 μg/ml Crystal Violet; the other was used to inoculate a plate of LAIR Staphylococcal medium and a plate of MIAMI Staphylococcal medium. Clinical photos were taken of typical lesions. All plates were streaked identically within 2 hours of collection, and incubated at 35 to 37°C. A.. cultures were read at 24 hours, scored and picked by the same observer (D. T.). Cultures were preserved for return to Miami, where S. aureus was confirmed by tube coagulase test. S. pyogenes was identified by hemolysis on Sheep Blood Agar and bactracin sensitivity. Antibiotic sensitivities were evaluated by the Kirby-Bauer technique.

Results: Figure 3 shows the relationship of altitude to prevalence of

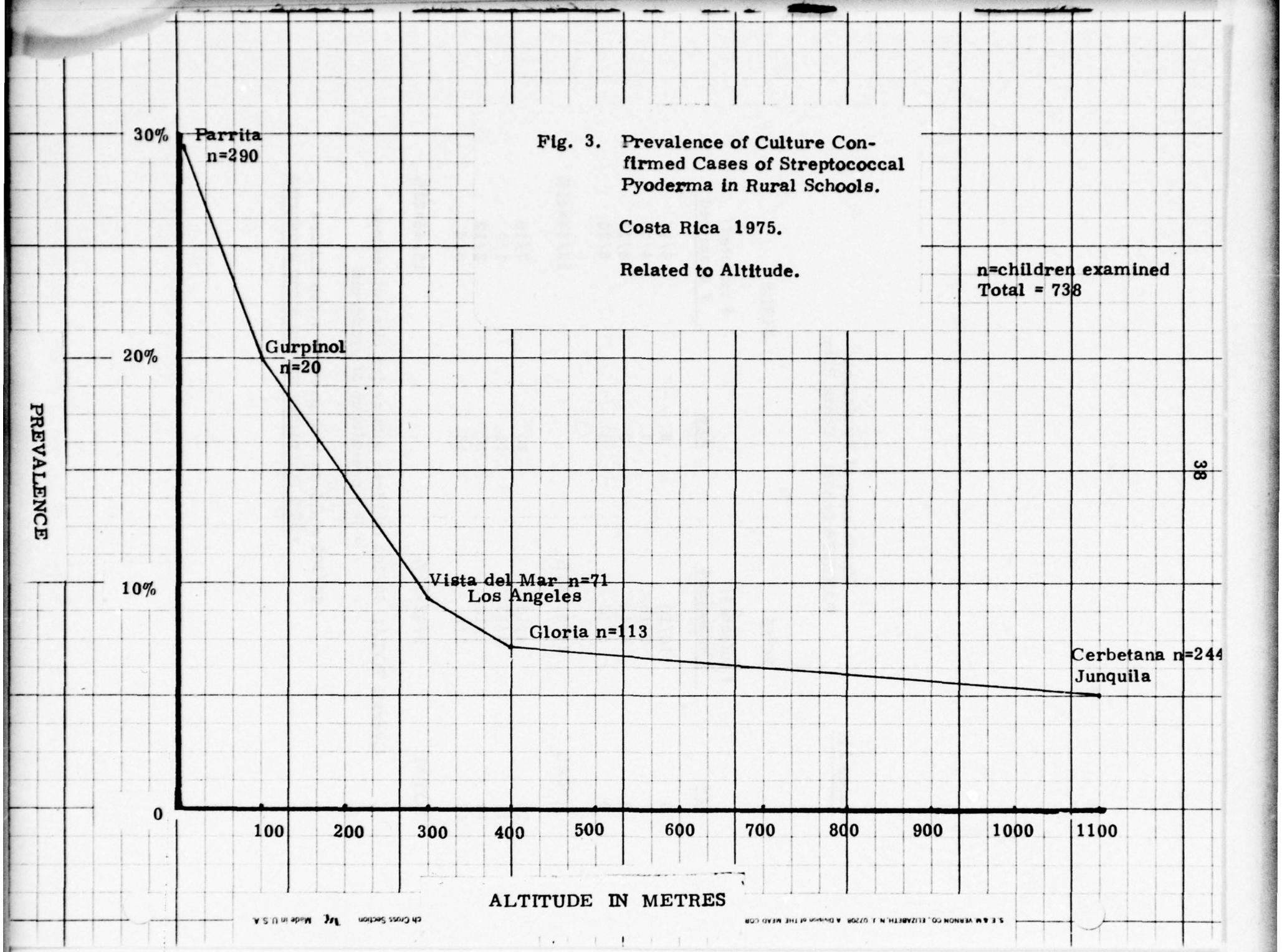


Fig. 3. Prevalence of Culture Confirmed Cases of Streptococcal Pyoderma in Rural Schools.

Costa Rica 1975.

Related to Altitude.

Table 11. Prevalence of Pyoderma
PARRITA School - Costa Rica

BOYS		GIRLS	
Age	# infected/ # examined	Age	# infected/ # examined
6	10/10	6	8/15
7	3/15	7	4/16
8	6/14	8	8/13
9	5/12	9	6/20
TOTAL	24/51=47%		26/64=41%
10	4/13	10	7/19
11	3/13	11	1/9
12	1/10	12	2/12
13	1/6	13	0/5
TOTAL	9/42=21%		10/45=22%

Overall TOTAL 69/202 children with active clinical lesions
= 34% prevalence of pyoderma

64/202 children with positive strep culture
= 32% laboratory proven strep pyoderma

Table 12. PARRITA School - Costa Rica

Type of Lesion	Total Children Sampled	Recovery of S. aureus	Recovery of Strep pyogenes
early	18	10 (55%)	12 (67%)
active	55	46 (84%)	54 (98%)
healing	10	7 (70%)	10 (100%)
TOTAL	83	63 (76%)	76 (92%)

Table 13.

Antibiotic resistance in S. aureus. Clinical isolates Costa Rica. Kirby-Bauer method. 322 strains tested.

Antibiotic	% resistant
Penicillin G	68
Tetracycline	15
Erythromycin	5
Chloramphenicol	3
Cloxacillin	1.2
Cephalothin	0.6

Table 14. 63 Post-Pubertal High School Students
Gloria High School

Diagnosis	Males (28)	Females (35)	Combined Prevalence
T. pedis	7	11	26%
T. corporis	3	4	11%
T. versicolor	7	5	19%
Pyoderma	3	4	11%*
Old leishmaniasis	6	6	19%

*only 4 pyodermas yielded streps = 6% proven strep pyoderma

confirmed streptococcal pyoderma. Many were severe or multiple infections. Only 12 Km distant, at an altitude of 300 M, the prevalence was only 8%. This was little different from schools at altitudes up to 1,100 M. Table 11 shows the prevalence of clinically active pyoderma in one Parrita school by age and sex. There was no difference in prevalence relating to sex, but there was a difference relating to age. The number of children examined represents the age distribution of the school enrollment (only 6 of 208 children were absent from school). The number of children at each year of age from 6 to 13 is too small for prevalence determination by year, but it can be seen that children of either sex under 10 years of age were twice as likely to be infected than their older school friends. The data further suggest that the six year olds were most at risk. Unfortunately, we could not examine preschool children without designing a separate study. However, the 70% prevalence (18 of 25) among the six year olds certainly suggests that younger children might also suffer a high prevalence of infection.

Table 12 is an attempt to determine the initial etiology of the common skin infections. Lower recoveries of S. aureus and S. pyogenes were obtained from early lesions when compared with active or healing lesions. Overall, however, the figures are close to those we obtained in previous tropical areas, i.e. over 90% of all purulent skin infections, regardless of the initiating factors or clinical appearance, yield a Group A Streptococcus pyogenes.

Antibiotic resistance: Antibiotic sensitivities were performed by the Kirby-Bauer technique on the S. aureus and S. pyogenes recovered during these studies.

Table 13 shows the percent of strains of S. aureus resistant to six antibiotics. There was no geographic clustering of resistant strains. This data is interesting because of the high percentage of strains resistant to Penicillin G (68%), from skin lesions of children in areas where antibiotics were not available and few if any children had ever received penicillin. This is similar to Dr. Allen's findings in a remote village in Panama, and indicates that penicillin resistance is not necessarily related to the therapeutic use of penicillin. We even found strains resistant to Cloxacillin, not available at all to the populations at risk, again indicating the presence of small reservoirs of resistant strains in remote rural areas. One strain from a patient was resistant to Penicillin G, Ampicillin, Tetracycline, Cloxacillin and Chloramphenicol. The same patterns of resistance were found in strains isolated from Hippelates flies; 9 of 18 strains were resistant to Penicillin G. One was also resistant to Cloxacillin. All S. aureus isolated from any source was sensitive to Neomycin.

Ninety-five percent (95%) of all S. pyogenes tested (129 strains) were sensitive to Bacitracin (i.e. presumptive Group A). Only 5 cases in the entire survey yielded a non-group A strep as the only hemolytic streptococcus recovered. Eighty percent (80%) of isolates were resistant to Neomycin, 5%

were resistant to Tetracycline, and all were sensitive to Penicillin G, Chloramphenicol, Erythromycin and Cephalothin.

We were impressed by the abundance of Hippelates flies seen feeding on the purulent skin lesions and fresh abrasions of the Parrita children. Two students captured 14 flies on or near skin lesions in individual sterile containers. Three days later they were squashed in sterile saline and one drop was streaked on culture media. Six yielded S. aureus and four yielded β Hemolytic Streps.

Table 14 depicts the results of a survey in a high school at Gloria (altitude 400 M), where the students were aged 13 to 19. This was the only population in which we found dermatophytosis and Tinea versicolor. One in every four students had Tinea pedis, one in ten had Tinea corporis, one in five suffered from Tinea versicolor, and every fifth student carried one or more scars of cutaneous leishmaniasis (all of these had active leishmaniasis while living as children in Turialba or Puriscal). We found no cases of the "post-pubertal" skin diseases listed above among 113 children, 7 to 13 years old, in a school only 2 Km distant and only 60 M higher, but we did find exactly the same prevalence (6%) of streptococcal pyoderma.

DISCUSSION

These studies clearly illustrate what can be achieved in a short period of time by well-motivated and carefully selected field teams, and further illustrates the potential value of the mobile laboratory field unit. Following the "shake down" trip in the first week, the entire series of studies outlined here were completed during one additional week in the field. Thus, a team which had never worked together before, was able to conduct studies within a month of the arrival of the trailer unit in Costa Rica, and arrived at the following conclusions:

1) Throughout the entire school system between San Jose and Parrita, the only populations at serious risk to skin infections were children in the delta area of the Rio Parrita. Skin infections in all schools over 300 M altitude are unlikely to reach prevalences over 10% of the school enrollment.
2) In Parrita, the youngest children had the highest prevalence, suggesting further investigation of pre-school children. Boys and girls are equally at risk.
3) The high prevalence of infection was associated with an abundance of biting insects (mosquitoes and culicoides), and the presence of wound feeding eye gnats (Hippelates). Musca domestica were found at all altitudes, but Hippelates were only found below 300 M.
4) Group A Streptococcus pyogenes were recovered from over 90% of purulent lesions. Endemic or epidemic Acute Glomerulonephritis could pose serious problems among the younger children of Parrita, and should be investigated.
5) Penicillin resistant S. aureus are abundant even in rural areas where little or no penicillin is used.
6) Further studies on bacterial skin infections including clinical therapeutic trials should be conducted in Parrita. Other locations would not be worth the effort.
7) A comparison of two diagnostic methods for S. aureus indicated that accurate epidemiology may be conducted with little or no microbiological expertise even under adverse field conditions.
8) Dermatophytosis and Tinea versicolor are post-pubertal diseases. Children under 14 would be inappropriate subjects for further studies.

We considered these experiences an excellent start to the field programme in Costa Rica. The concept of a mobile field epidemiology unit was so impressive to our Costa Rican colleagues that plans were made to establish a division of Epidemiology at the University, build around the trailer project. In addition, our experiences in Costa Rica opened up rich new potential for future studies, particularly in programmes of prevention and therapeutic trials. Following the use of the trailer system as a mobile epidemiology unit, another team evaluated its potential as a travelling clinical laboratory.

Epidemic Furunculosis.

The following epidemic began on July 3, 1975, and continued beyond the period of this contract, but is reported in toto.

On July 3, 1975, an 18 year old male abraded a large area of his back when he fell off the hood of a moving car on to a rough road surfaced with oolitic limestone near Pinecrest on Route 94 in the Everglades. On July 6, his extensive abrasion was obviously infected, covered with eschar under which was a purulent exudate. The surrounding skin was erythematous and he had a fever. He was advised that he needed antibiotic therapy and should immediately seek medical attention. This he failed to do, and instead was administered first aid by a girl friend who bathed off the crusts with a clean towel and warm saline. This towel was then placed in a washing machine on cold cycle, along with the shirts, jeans and underwear of ten teenagers who were living in a house trailer in the Everglades over the July 4th weekend. 8 of these 10 teenagers developed furuncles within two weeks, and the remaining two within four weeks.

Cultures from the original case and all of the subsequent 110 furuncles which developed yielded pure growths of Staphylococcus aureus, phage type 29/52/80, resistant to penicillin and tetracycline.

This group of young people formed a close knit "family" or social peer group numbering 21 individuals. They came from 13 different households scattered over an area of 50 x 5 miles from the small village of Pinecrest in the Everglades to the suburbs of southwest Miami. The outbreak was almost entirely confined to the peer group, 19 of whom eventually developed furuncles. There was a secondary "epidemic" in a single family (family A) comprising two adults and thirteen children. In this household, sleeping conditions were crowded, and all but two members of this family developed furuncles.

The investigator (David Taplin) interviewed each new case, photographed and cultured the lesion, and advised them to immediately seek whatever medical attention was normally available to them (family doctor, clinic, etc.), or to report to the emergency room of the nearest hospital. By the 58th episode of furuncles, it was clear that local physicians and hospitals were not approaching the problem as an epidemic, and in 13 episodes, an inappropriate antibiotic was prescribed, usually Ampicillin. The local Public Health authorities offered advice and guidance, but declined to identify the outbreak as a public health problem, since it was confined to a small group who were individually advised to see their doctor. In the eighth month, all subjects and their contacts were offered free services at a community clinic and urged to report before a new furuncle ruptured.

We had become aware by this time that early treatment with cloxacillin could abort a developing furuncle, and that this could prevent further spread to contacts. It also became evident by carefully matching case histories, that transmission was associated with skin to skin contacts. The scatter diagram of body locations of furuncles (Fig. 4) will give an indication of the type of contact most probably involved. 69 sets of cultures from the anterior nares, finger tips and perinuem were made in the peer group. The perineum was the most common source of posi-

tive cultures for S. aureus. (37 of 69). Anterior nares were positive in 23 of 69 attempts, and the finger tips 13 times in 69 attempts. 30% of perineal cultures were the indicator strain as were 40% of the finger tip cultures. Only 20% of the strains from the anterior nares were the same strain as that causing the furuncles based on antibiograms and phage typing. S. aureus was recovered ten times from 25 cultures of the crotches of blue jeans and underwear, but the indicator strain was recovered only once, from the jeans worn by a girl with a concurrent furuncle.

12 of the first 18 persons who developed boils had regularly used an antibacterial soap. Family A were advised by their physician to bathe daily in a hexachlorophene containing detergent solution, which was also added to the bath water. They continued this regimen for three months, during which 16 furuncles occurred in ten of the thirteen family members. The prior or continued use of antibacterial soaps had no effect on the acquisition of furuncles. Among the first eighteen cases, six were users of a non-medicated soap, and twelve used popular brands of antibacterial soaps.

The family which most vigorously used an antibacterial agent in the form of a hexachlorophene detergent had the highest attack rate of boils. This experience suggests that regular and exclusive use of these products was not effective in preventing furuncles.

During the first six months, every pustule or "pimple" was cultured as it occurred. In 15 attempts at culture in which S. aureus was not recovered, none developed into a furuncle. In more than 50 occasions when the small pustule produced S. aureus , all developed into furuncles, and the strain was the indicator strain (29/52/80).

The epidemic was finally brought under control in April 1976, when all households at risk were educated in the early use of cloxacillin, and sufficient supplies of antibiotic were given to each household. Nevertheless, an "escapee" from the peer group moved to Naples, Florida in June 1976, developed a new furuncle, and was treated with tetracycline, to which he did not respond. During the following three months, 8 new cases occurred in Naples, and all were clustered socially around the "new" indicator case. No new cases occurred until March 1978, when six additional cases occurred in the original peer group within two weeks. This investigator (David Taplin) was out of country at the time, and although most of the group had now become adults, they showed no initiative in tackling this new outbreak, although they fully understood the mechanisms.

On return of the investigator to this country, all were immediately treated with cloxacillin, and no new cases have occurred as of July 3, 1978, three years after the initial episode.

Discussion: This epidemic clearly began as a common source outbreak, which later developed into a propogated epidemic. The towel, heavily contaminated with pus, may have been the source of a massive inoculation of clothing on July 6, 1975. Although all ten individuals who washed their clothes in that load developed furuncles within four weeks, so did eight others who stayed in the Everglades that weekend and did not wash their clothes.

In any event, all of the 21 cases occurring in the first six weeks had spent all or part of the July 4th weekend in the house trailer. From then on, it is clear that transmission occurred primarily through close body contact. Except for Family A, there was a low rate of transmission in their own households, and in general, the infections were not passed on to family members who were not in the peer group.

This study leads this investigator to the conclusion that early treatment with appropriate antibiotics is indicated in the management of furunculosis. Many physicians do not share this view, believing that incision and drainage is the method of choice, and that antibiotic therapy adds little to the management.

The pattern of spread in this epidemic strongly indicated that a draining boil was a significant source of new infections among close contacts. There was also a beneficial effect in reducing recurrences in the same patient. The choice of ampicillin by at least four physicians was surprising. Even without sensitivity tests, the chances of a boil-producing S. aureus of Group I phage types being sensitive to penicillin is only 20-30%. In these instances, the physicians were informed of the resistance to penicillin, but apparently were unaware that ampicillin is a β-lactamase degradable penicillin. Four patients received extensive and expensive work ups to uncover possible immunologic defects or other systemic problems in spite of the knowledge that they were part of an epidemic involving at least twenty other individuals. Not a single person in any medical facility questioned the patients or parents regarding contacts or other persons with furuncles during more than 100 visits.

More physicians in our area are now doing this after attending post-graduate courses at our institution, with the result that two more clusters of furuncles have been uncovered. In one cluster of seven individuals, all young adults, the common incident was a sexual encounter. In the other instance, six other cases were found when the patient, a twenty year old woman, was questioned, but the mode of contact was not established.

In summary, it is our belief that physicians treating furuncles should investigate the possibility that their patient is part of a cluster, that appropriate antibiotics have a role, and that early treatment of new furuncles before they rupture will help in limiting the spread.

Finally, it is apparent that the offending organism can remain undetected for many months without producing overt infection. We were unable to detect a common carrier or spreader in the group, nor was any single location identified as the source. The house trailer in the Everglades was never used again by the group and could not be implicated after the initial episode. A family which moved into the trailer did not develop furuncles. The only consistent feature was person to person contact. Clothing was often shared, but in only two instances did this result in a new furuncle in the clothing recipient.

Unlike streptococcal pyoderma, furuncles did not require skin trauma as the initiating insult. As is well known, these boils began as a single infected hair follicle. Patients who developed several boils in the same body site believed that this represented recurrence of the same boil, but close up photography showed they were always newly infected hair follicles.

Table 15 . Attack Rates.

Peer Group	19/21	=	90%
Family A	10/13	=	77%
Other Families	7/46	=	15%
School contacts		=	0
Other contacts		=	0

Table 16 . Frequency of Boils in One Year.

Peer Group:	67 boils in 19 patients	3.5 per patient
Family A:	26 boils in 10 patients	2.6 per patient
Other Families:	9 boils in 7 patients	1.3 per patient

Table 17 . 73 Episodes of Boils.

63%	Of those receiving incorrect or no antibiotics had a recurrence of boils within one month.
4%	Of those receiving correct antibiotic had a recurrence within one month.
86%	Receiving incorrect or no antibiotics had a recurrence within three months.
25%	Receiving correct antibiotic had recurrence within three months.

Table 18 . Reasons for failure to receive Correct Antibiotics.
(58 Epidsodes of Boils)

Did not seek medical attention	38
Prescribed incorrect antibiotic	13
Correct antibiotic but did not take pills	7
Took pills not prescribed (shared a friend's prescription)	16*

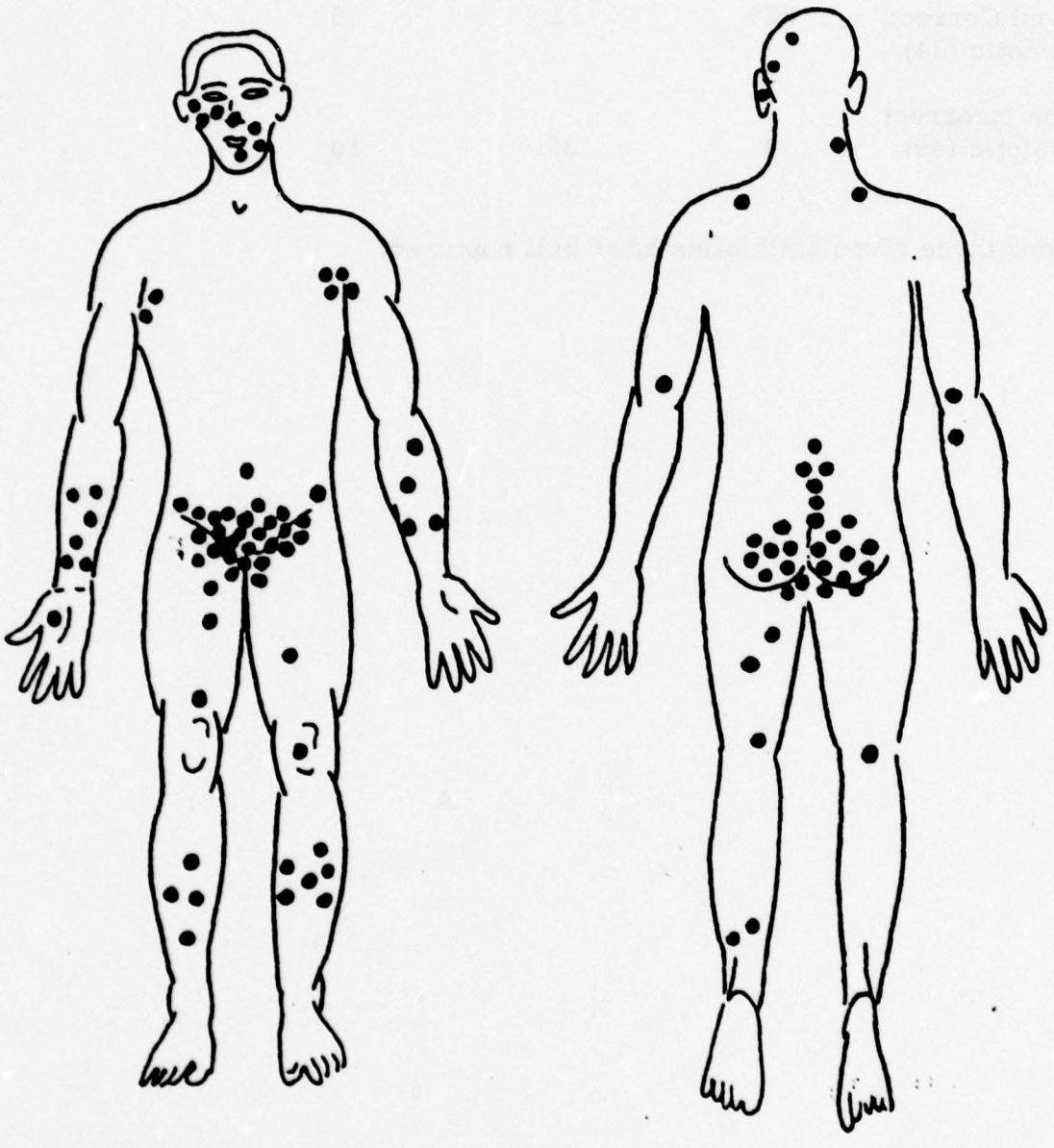
*None of these cases took more than 2 grams cloxacillin total.

Table 19 . 73 Episodes of Boils.

	Boil Aborted	Recurred in one month	Recurred in three months
Received Correct Antibiotic (24)	23*	1	5
None or Incorrect Antibiotic (49)	4	31	10

*Includes three given antibiotics after boil ruptured.

DISTRIBUTION OF 110 FURUNCLES



TAPLIN 1976

Fig. 4

Boil Epidemiology over 18 months
Total boils = 117

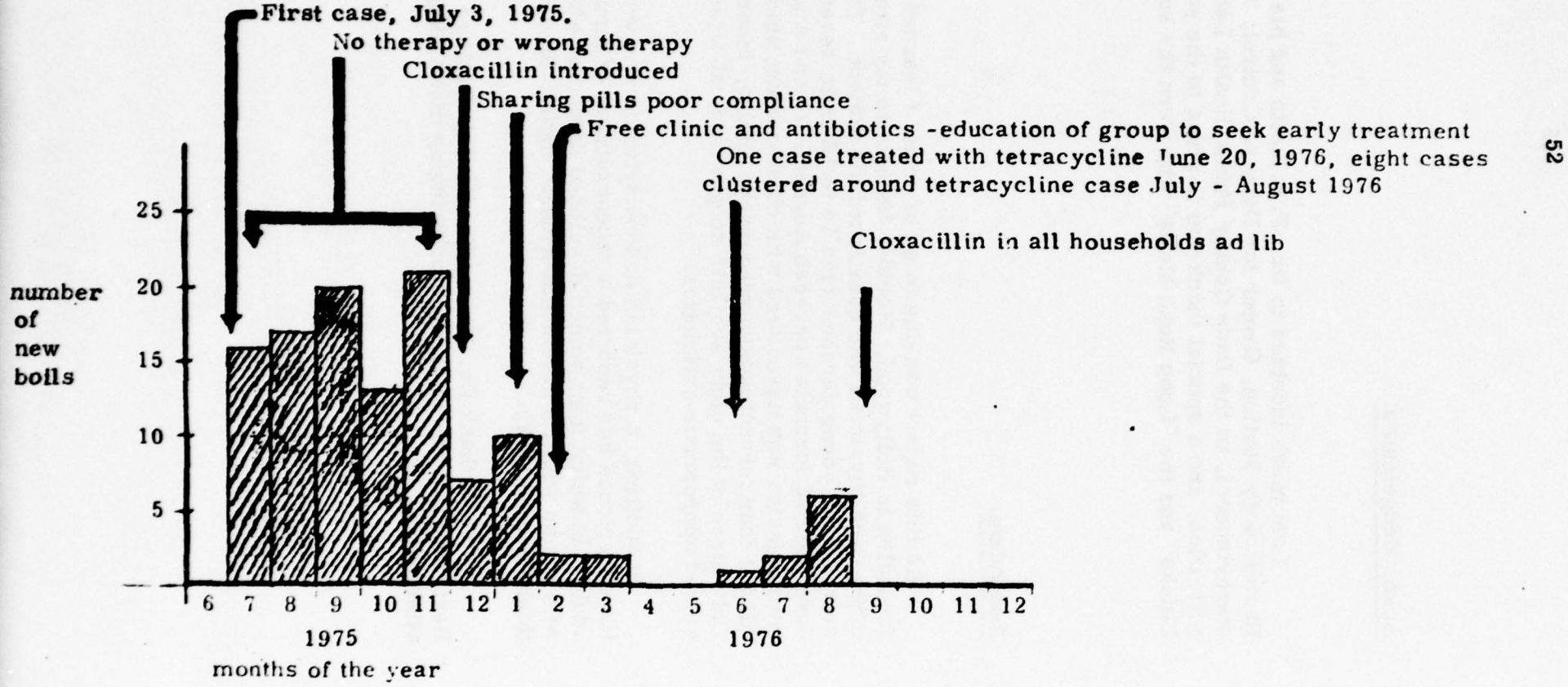


Fig. 5

Acknowledgements.

I am much indebted to Dr. P. B. Smith and his staff of the Clinical Bacteriology Section, Center for Disease Control, Atlanta, for phage typing of the staphylococci, to the Dade County Public Health Laboratory for monitoring our activities, and a special thank you is given to the young members of the 'Chickee Chicks" and the "Loop Road Mafia" who were the subjects of this investigation.

Addendum.

As this report was due to go to print, I learned of a fourth cluster of furuncles in Hollywood, Florida, brought to my attention by an alert primary care physician who questioned his patient. This latest outbreak involves eight young persons aged 15 to 18 from seven households who have developed 23 furuncles between August 1977 and August 1978. Once again, transmission was associated with close contact among a young peer group. All but four furuncles occurred on the groins, inner thighs and buttocks. Only three of the eight subjects sought medical attention, and only one received appropriate antibiotics.

In addition, a physician in Pennsylvania who was familiar with our Florida experience has reported a recent cluster of furuncle cases among young adults, in which four women developed furuncles after sexual encounters with a man with recurrent infections. Again, the lesions were in the inner thighs and buttocks.

I wish to thank Dr. Harvey Blank, Dr. Richard Feinstein, Dr. Kenneth Hertz and Dr. Steven Orman for bringing these additional outbreaks to my attention.

BACTERIAL INFECTIONS - PREVENTION

The Chinle Study. 1975.

Summary.

In a two month period of carefully monitored showering on a daily basis, we could detect no effect of antibacterial soap in the prevention of skin infections among school children aged six to thirteen.

The prevalence of S. aureus on normal skin was consistently lower in the antibacterial soap group than in the placebo group. There was an increase in the prevalence of Group A S. pyogenes on normal skin related to the use of active soap for two months, particularly among the girls. However, recovery of Staph and Strep from normal skin by the RODAC system did not correlate well with clinical disease, and probably represents transient contamination rather than skin colonization.

In vitro studies showed enhanced activity of active soap when compared with the placebo soap against S. aureus but not against Group A S. pyogenes.

The distribution and streptococcal etiology of the skin infections were typical of common skin infections seen in the United States, Africa and South America.

Double Blind Trial of an Antibacterial Soap for the Prevention of Common Skin Infections

It is evident from our studies in Vietnam and with the Colombian Army that the most common cause of bacterial infection of the skin among military personnel exposed to rugged environments is likely to be Streptococcus pyogenes.

In the late sixties, a recommendation was made from the Armed Forces Epidemiological Board that the use of antibacterial soaps should be encouraged as an aid to the prevention of bacterial infections of the skin. This recommendation was based previously on studies conducted at West Point and Annapolis military academies, which showed an apparent statistical reduction in primary skin infections.

No controlled studies have been conducted to our knowledge to determine the value, if any, of antibacterial soaps in the prevention of the more common streptococcal infections of the skin.

The value to the military of such a study is obvious. We were, therefore, enthusiastic when offered the opportunity to conduct such a study in a population with a high prevalence of infections.

Background.

Following planning meetings with the University of Miami investigators, the Bureau of Indian Affairs (Chinle, Arizona), the Principal of Chinle Boarding School, and the Food and Drug Administration, a study was initiated at the Chinle Boarding School, Chinle, Arizona, in an attempt to answer the question:

> Is there value in the daily controlled use of an antibacterial soap bar* compared to plain soap bar in the prevention of bacterial skin infections?

Essentially, we assigned commercially available soap bars to specific dormitories, of the type which would routinely be used in the school.

In the scientific sense, Chinle Boarding School was ideal for the study of this kind because the children were for most of the time in residence, separated into dormitories by age and sex, each with its own shower facilities physically separated from each other. A daily attendance sheet was available, and we had excellent cooperation from the school administration with permission to monitor soap usage. Previous reports suggested that skin infections had been endemic in the school for some years.

Materials and Methods.

All children enrolled at the school were included in the study. Color coded, but otherwise identical, soap bars were assigned to each dormitory. Half of the population were assigned an active bar and half the placebo. The pattern of distribution of the soap was assigned to achieve as far as possible equal weighting according to age and sex and the results of baseline clinical studies (prevalence of infection), but the code was not known by the investigators.

Prior to the start of the study, all soaps and shampoos were removed from the school and replaced with plain soap and shampoo for a period of one month.

Throughout the first two month period, soap usage was monitored by the dormitory supervisors and by our own monitor. Children were checked off a roster each time they showered (once per day), so that we are confident that soap was adequately monitored.

On each of three occasions, every child available was examined from head to toe by two clinical dermatologists (Drs. Eaglstein and Feinstein). Any trauma of the skin (cuts, scratches, abrasions, bites, rashes) was recorded on a body diagram sheet. In addition, all infected lesions were recorded, according to the following criteria:

> A lesion surrounded by erythema and containing pus, regardless of shape, size or extent of lesion, was scored as a clinical infection. Crusted lesions surrounded by erythema were recorded as possible infected. When the crust was removed from lesion at station 2 (microbiology) it was confirmed as infected if pus was present under the crust. If the lesion was dry, and no

*Active soap contained 1.5%, 2:1 TCC:TFC.

pus could be expressed by superficial incision and firm pressure, the clinical observation was changed to not infected.

All lesions scored as infected or possibly infected at station 1(clinical) were cultured. All children with infected lesions, and all children with odd study numbers, were sampled for the presence of staph and strep on normal skin sites (mid scapular and inner aspect left wrist) using RODAC contact plates. The choice of these sites was decided on the basis of studies by Dr. Mary Marples (The Ecology of the Human Skin) relating to bacterial densities in various skin sites, and to provide a basis of comparison with the work of the University of Minnesota group under Dr. Wannamaker, who used the same sites in Red Lake Indian Children.

Media used were:

1) Trypticase Soy Agar with 6% sheep blood and 0.8 μg/ml crystal violet for Streptococcus pyogenes (hemolytic strep), accepted by Wannamaker, Dillon, Parker, Potter, Allen and ourselves as the best available medium for isolation of strep.

2) PYM II (Miami), a well tested selective medium for Staph. aureus contains Polymyxin B, Mannitol, Brom Cresol Purple and yeast estract. This medium has consistently given higher recovery rates and is more selective than standard Mannitol Salt agar, sheep blood agar, or glycine tellurite agar.

All media used in this two month study were made from the same batches of ingredients of equal shelf life since manufacture, autoclaved identically, incubated at 37^{o}C, and read at the same time interval after culture (24 to 36 hrs.).

We therefore consider the quality control of the media and methods to be as consistent as could be obtained.

Results.

In compiling these results, we have removed from the study all children who received systemic antibiotics (penicillin, ampicillin, tetracycline, erythromycin), all children who were absent from school for more than one week in any one month, and children who were not present for examination at the time of the three surveys.

This left 401 children who were known to have used the soaps under the supervision of our own monitors, remained in school and who received no antibiotics. These are termed "completers" in this report. 301 children were listed as "non-completers" and have been evaluated separately.

Clinical Infections.

Figure 6 shows the point prevalence of clinical infection for all "completers". There was no significant difference in the prevalence of clinical infection between the children using antibacterial soap and those using placebo after two months of supervised daily use.

Recovery of Staph and Strep from Normal Skin.

The influence of soap use on the prevalence of recovery of Staphylococcus aureus from normal skin sites is shown in Figure 7.

There was slightly higher recovery of S. aureus from the group assigned to placebo bars at the baseline study, and this differential remained the same throughout the two months if all the "completers" are considered together.

Figure 8 illustrates the point prevalence of recovery of Group A Streptococcus pyogenes from normal skin sites. There appears to be a significant change in the recovery rates of S. pyogenes relating to the use of antibacterial soap. In spite of the fact that there was twice the recovery rate at the baseline from the placebo group compared with the active groups, at the end of two months this ratio was reversed, and there were more children with positive cultures for S. pyogenes from normal skin in the active soap group.

Environmental Sampling.

Because we were beginning to have doubts by the end of two months concerning the RODAC system of sampling as a measure of "colonization" as opposed to transient contamination, we sampled 25 bed sheets in two dormitories using RODAC plates. The children at that time were continuing to shower on a daily basis and sheets had been changed the day before. We sampled the bottom sheet 12" below the pillow. Seven of 25 sheets (28%) yielded S. aureus. These figures were almost identical with the levels we obtained from normal skins, indicating, we think, that the skin surfaces were simply another surface which could be contaminated by transient microorganisms.

In Vitro Testing of Soaps.

At the end of the two month study, we investigated the effect of the soaps on the Staphs and Streps isolated at Chinle. One gram of soap chips was dissolved in 100 ml distilled water and serially diluted in Trypticase Soy Broth to produce a 9 tube assay. Standardized suspensions of S. aureus and S. pyogenes were added to each tube. Duplicate sets were made with the addition of Fetal Calf Serum to give a final concentration of 10% in the broth. Table 20 shows good activity for the active soap to the 7th tube against Staph aureus. Activity was inhibited somewhat by the addition of serum. Little activity could be detected in the placebo soap.

Table 21 shows activity for both soaps against S. pyogenes presumably due to the fatty acids present in the soap. This activity was greatly diminished by the addition of serum, but we could detect no increased activity of the antibacterial soap over the placebo.

Evaluation of Clinical Scoring.

At the first two examinations, Dr. Feinstien recorded 49 subjects with clinically infected lesions, of whom 45 harbored Staph and/or Strep (92%). Dr. Eaglstein recorded 33 subjects with clinical infections, of whom 30 carried the organisms in their lesions (91%). Thus, the accuracy of diagnosis was very closely associated withpositive laboratory findings, and the two observers were very closely matched in their diagnostic criteria.

Analysis by Dormitory.

Data were analyzed by dormitory as well as by individual children because of the possibility that infected children were spreading the organism among their dormitory mates.

There was no relation of antibacterial soap usage to changes in the prevalence of infection or recovery of S. aureus from normal skin, between the baseline period and months one and two. However, the increase in prevalence of S. pyogenes from normal skin of antibacterial soap users between months one and two was significantly greater than in the control subjects. This analysis supports the findings based on point prevalence for individual children that S. pyogenes was more frequently recovered from normal skin in the active soap dormitories after two months, and tnat the prevalence was significantly greater in the girls' dormitories using this soap. The results also suggest there was exchange of bacteria among children living in the same dormitory. This factor should be considered in the design of any future studies.

Discussion.

Despite various methods of analysis, we could detect no effect of the antibacterial soap on the prevalence of clinical infections after two months of vigorously monitored use. This was true whether the population was analyzed by point prevalence in individual children or by dormitory, or by comparing "completers" alone or the entire population at risk.

The correlation of laboratory microbiology with clinical judgement of the two physicians was high, and we have little doubt that we were dealing with an endemic situation of skin infections in which Group A - Streptococcus pyogenes was the principal agent involved, with S. aureus as a secondary colonizer perhaps contributing to the severity of delayed healing of the infections.

The microbiology of the infections was very similar to other populations we have studied. (Table 22).

Table 22

Location	Climate	number cultured	recovery of S. aureus(%)	recovery of S. pyogenes(%)
Miami	subtropical	252	59	95
Apartado, Colombia	tropical	91	90	90
Medellin, Colombia	temperate	50	62	84
Chinle (baseline)	arrid, hot	40	60	80
Parrita, Costa Rica	tropical	83	76	92

The results are similar to those of our studies among combat soldiers in Vietnam and Colombia, and to those of studies in children by Dillon (Alabama), Esterley (Baltimore), Poon King (Trinidad), and Wannamaker (Minnesota).

All of these authors studied common skin infections in populations at large and recovered S. pyogenes Group A from 68% - 93% of lesions, and S. aureus from 39% - 75%. We therefore believe that the Chinle infections were rather typical of common skin infections in the United States. Throughout the Chinle study we did not find a single case of staphylococcal bullous impetigo.

The lack of benefit of the antibacterial soap over a period of two months use in the prevention of infections was in accordance with our in vitro data, which showed no advantage of the active over the placebo soap against Streptococcus pyogenes.

There did appear to be a consistent reduction of S. aureus on normal skin of the antibacterial soap users, particularly in the girls, who may have used the soaps more diligently. This is reflected in the lower recovery from lesions. This is also not surprising in view of the in vitro data, which showed activity against S. aureus. However, the effect of S. aureus was not reflected in the prevalence of clinical infection.

We are well aware of the importance of this study in helping to establish the benefit to risk ratio of antibacterial soaps. We believe that the two month supervised portion of the study represents the best available investigation so far conducted, and we conclude that no effect could be shown for prevention of streptococcal pyoderma over a period of two months.

Obviously, if the use of this or any other antibacterial soap encourages the colonization of normal skin by S. pyogenes, and if this can be correlated with an increase in clinical infection, it would be an important fact to take into consideration on the risk side of the evaluation. This study has shown a statistical increase in the recovery of S. pyogenes on normal skin associated with the use of an antibacterial soap. However, the RODAC system has never, in our knowledge, been

adequately evaluated with regard to sensitivity or reproducibility. The fact that bed sheets produced similar recoveries suggests that our information from skin is no more relevant than that from inanimate surfaces, and although it may reflect the general level of contamination of the environment, it adds little to our knowledge of skin "colonization", and nothing to the evaluation of health risks. In fact, we could find no evidence that the prevalence of Streptococci recovery from normal skin was followed by an increase in clinical infection, unlike data of Wannamaker and colleagues working with Red Lake Indian children.

Before suggesting that use of antimicrobial soaps results in an increase in colonization of the skin by S. pyogenes, we would like to confirm this by additional studies. We would also like to know much more about the value of colonization and transient contamination.

POINT PREVALENCE OF CLINICAL INFECTIONS
COMPLETERS ONLY
Children with one or more clinical infections as a percent of each population at risk.

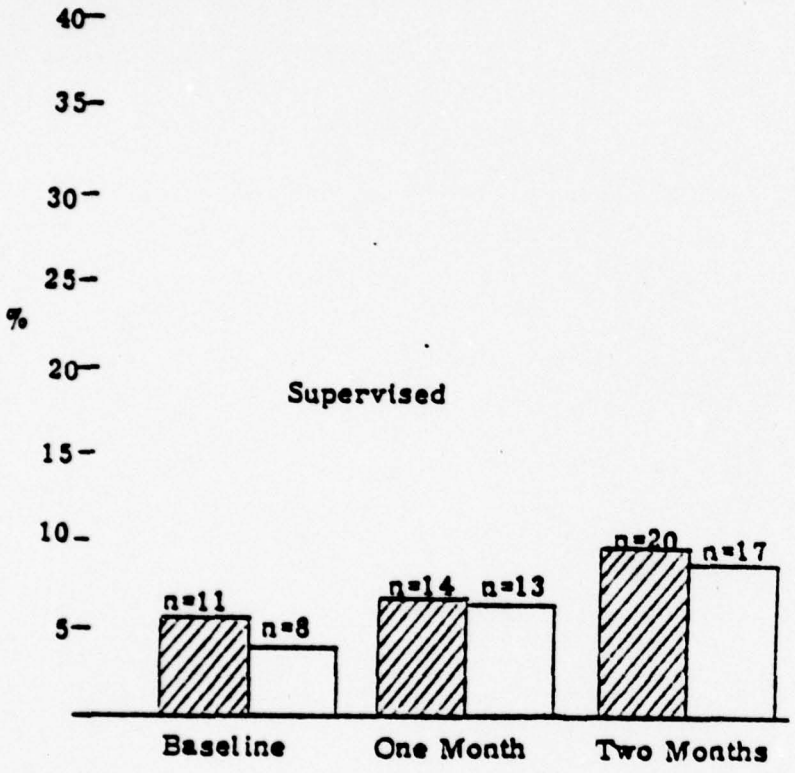
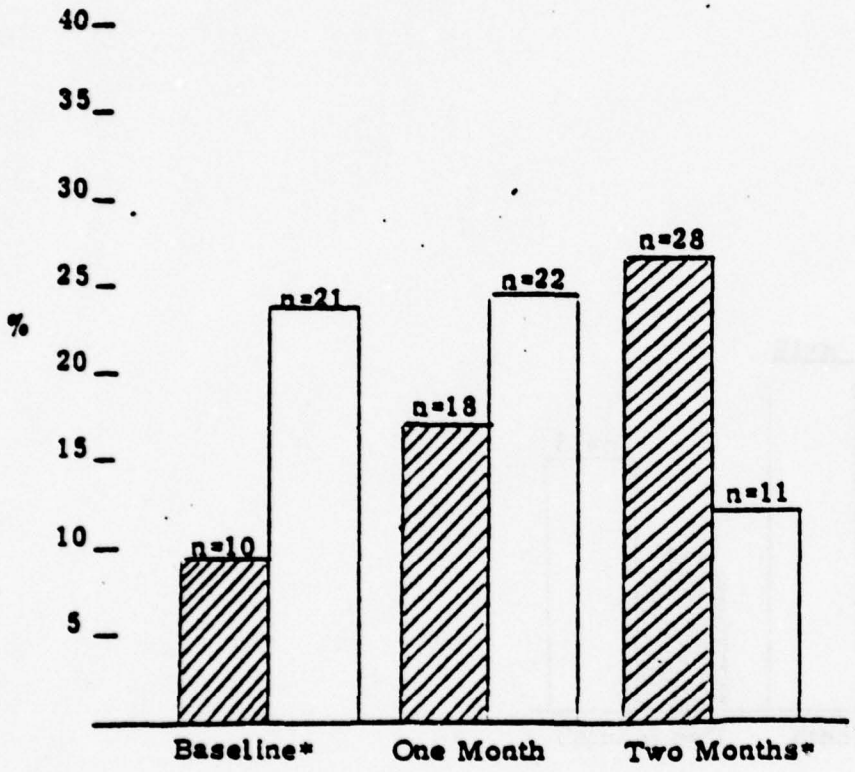


Figure 6

POINT PREVALENCE OF STREP PYOGENES
NORMAL SKIN, COMPLETERS ONLY
Children with one or more positive skin sites by RODAC method
as a percent of the population at risk.



*The differences between active and placebo at these points prove to be significant at the 0.05 level according to Chi-Square.

Figure 7

POINT PREVALENCE OF STAPH AUREUS
NORMAL SKIN, COMPLETERS ONLY
Children with one or more positive skin sites by RODAC method as a percent of the population at risk.

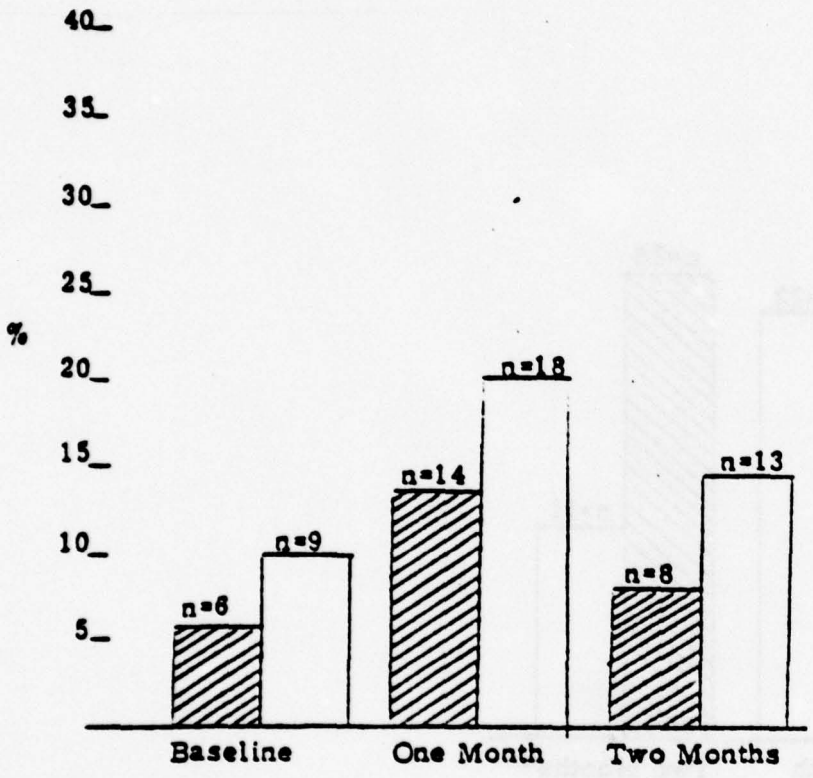


Figure 8

Table 20

Soap Solutions in Broth Inoculated with Chinle S. aureus

Tube #	Soap Conc, %	Antibacterial soap & distilled water	Antibacterial soap & Fetal Calf Serum	Placebo soap & distilled water	Placebo soap & Fetal Calf Serum
1	10^{-1}	no growth	no growth	1+ growth	2+ growth
2	10^{-2}	no growth	no growth	1+ growth	2+ growth
3	10^{-3}	no growth	no growth	2+ growth	1+ growth
4	10^{-4}	no growth	no growth	2+ growth	4+ growth
5	10^{-5}	no growth	1+ growth	2+ growth	4+ growth
6	10^{-6}	no growth	4+ growth	4+ growth	4+ growth
7	10^{-7}	no growth	4+ growth	4+ growth	4+ growth
8	10^{-8}	1+ growth	4+ growth	4+ growth	4+ growth
9	10^{-9}	4+ growth	4+ growth	4+ growth	4+ growth

Table 21

Soap Solutions in Broth Inoculated with Chinle Strep. pyogenes

Tube #	Soap Conc, %	Placebo with distilled water	Placebo with Fetal Calf Serum	Antibacterial soap c̄ distilled water	Antibacterial soap c̄ Fetal Calf Serum
1	10^{-1}	no growth	no growth	no growth	no growth
2	10^{-2}	no growth	no growth	no growth	no growth
3	10^{-3}	no growth	no growth	no growth	no growth
4	10^{-4}	no growth	no growth	no growth	no growth
5	10^{-5}	no growth	4+ growth	no growth	4+ growth
6	10^{-6}	no growth	4+ growth	no growth	4+ growth
7	10^{-7}	no growth	4+ growth	no growth	4+ growth
8	10^{-8}	no growth	4+ growth	no growth	4+ growth
9	10^{-9}	4+ growth	3+ growth	4+ growth	4+ growth

Costa Rica. 1977.

The following study was conducted after termination of this contract, but is clearly of military significance, and is therefore included.

323 healthy male and female subjects 5 to 11 years of age, were selected at two schools in Parrita, Costa Rica (see pages 33-45). Individual signed informed consent was obtained from parents, protocol was previously reviewed by the Ministry of Health, the University of Costa Rica, and the study was monitored by both agencies.

Subjects were randomly assigned to be treated with 2% chlorhexidine gluconate in water (Hibitane) or purified water (placebo) to test their effects on wound infection. Both preparations also contained 4% isopropanol. Treatment consisted of washing the whole body of each child excluding the head, buttocks and genitals. This procedure was done on Monday through Friday. Each subject was evaluated prior to treatment and twice per week for number and location of newly infected and non-infected lesions. A lesion was defined as any primary injury to the skin (insect bites, scratches, abrasions, puncture wounds or lacerations). One school was evaluated for 5.5 weeks, the other for 6.5 weeks). The study population had the following characteristics:

Table 23

	Hibitane	Placebo
Number of subjects	152	153
Sex (male-female)	69-83	67-82
Average age (years)	8.8	8.9
Average height (inches)	50.7	51.2
Average weight (pounds)	60.1	61.4

Compliance:

Table 24

	Potential visits	Actual visits	% attendance
Placebo	1823	1629	89.4
Hibitane	1802	1552	86.1

Conclusion: No substantial difference between groups for rate of attendance.

Results:

Table 25 . Subjects with one or more new lesions* during the trial.

	Hibitane	Placebo
School A	87	83
School B	63	70
Subjects in Group	152	153
% subjects with new lesions	99	100

Conclusion: Both groups were equally at risk to infection.

Table 26 . Subjects with one or more newly infected lesions during the trial.

	Hibitane	Placebo	
School A	8	19	
School B	7	19	
Both	15	38	P<0.001
Subjects in Group	152	153	

Conclusion: Highly significant difference in number of infected children in favor of Hibitane.

Table 27 . Total new lesions* and newly infected lesions.

	Hibitane		Placebo		
	new lesions	newly infected lesions	new lesions	newly infected lesions	
School A	925	9	914	40	
School B	476	7	612	51	
Both	1,401	16	1,526	91	
%infected		1.14		5.96	P<0.001

Conclusion: Highly significant difference in number of infected lesions in favor of Hibitane.

*lesion: any minor trauma to skin (cut, scratch, abrasion, insect bite).

Table 28 . Subjects with one or more newly infected lesions by week.

Placebo Group.

	point prevalence	Incidence of subjects with new infections					
week	0	1	2	3	4	5	6
subjects in group	153	146	147	146	143	140	123
subjects with new infections	15	12	9	7	17	13	7
%	9.8	8.2	6.1	4.8	11.8	9.3	5.7

Hibitane Group.

	point prevalence	Incidence of subjects with new infections					
week	0	1	2	3	4	5	6
subjects in group	152	144	142	136	130	130	117
subjects with new infections	17	1	2	2	5	4	0
%	11.0	0.7	1.4	1.5	3.8	3.0	0.0

Total subjects with new infections in six weeks:

Placebo = 65

Hibitane = 14

$P<0.001$

MICROBIOLOGY SECTION.
from Study of Chlorhexidine Gluconate, in Costa Rica

Methods

Two types of media were used which have proven reliable over many years:

a) Trypticase Soy Agar with 0.8% Bacto Crystal violet and 6% defibrinated Sheep Blood. A selective enriched media for the recovery of Streptococcus pyogenes.

b) PYM II: a highly selective medium for Staphylococcus aureus. Developed at the University of Miami. Gives higher recovery rates than other staphylococcal media or plain blood agar. Contains Nutrient Agar, polymyxin B, actidione, mannitol, yeast extract and Brom Cresyl Purple. This medium is purple in color, and turns to golden yellow in the presence of S. aureus. Inhibitory to gram negative bacteria, molds, other species of staphylococci and micrococci. Has a good shelf life.

Neutralizers: Neutralizing solution for chlorhexidine gluconate was supplied by sponsor for incorporation into media, (3% Azolectin and 10% Tween 80 in nutrient broth). Unfortunately the neutralizer is incompatible with blood agar and causes lysis of the red cells. It also interfered with the selectivity of PYM II. We therefore made two swabs of each lesion. One was plated directly on the two selective media. The other was held in neutralizer broth for 10 minutes prior to plating. Results of the two methods are shown in Table 29. Note that these results represent all attempts at culture, including lesions not suspected as infected.

Thus there were more recoveries of S. aureus after neutralizing, and fewer recoveries of S. pyogenes. It would require much larger numbers of paired cultures to determine whether these differences are significant.

For this study, cultures were scored as positive or negative for S. aureus and S. pyogenes regardless of the method of recovery. However, the choice of either method would have made no difference on the outcome of the study.

Microbiology of Clinically Infected Lesions.

Microbiology was conducted to confirm that lesions scored as clinically infected were of the usual common etiology (Strep/Staph) pyoderma).

Baseline cultures of infected lesions before treatment confirmed that we were in fact, dealing with the common type of skin infections, and that recovery rates of pathogens were those to be expected (see Table 30).

Table 29. Effects of neutralizer on recovery of pathogens.

	No. of attempts	Positive for Staph aureus	Positive for Strep pyogenes
Direct Plating	177	99 (56%)	111 (62%)
Plating After neutralizer	177	116 (65%)	93 (52%)

Table 30. Culture results. Infected lesions before treatment.

	Hibitane (17)		Placebo (15)	
	staph	strep	staph	strep
Baseline (before treatment)	15	15	13	13
Percent	88%	88%	87%	87%

Table 31. Culture results of infected lesions by week.

	Hibitane			Placebo		
end of week	no. cultured	positive staph	positive strep	no. cultured	positive staph	positive strep
1	1	1	1	10	8	7
2	1	0	0	9	7	9
3	2	1	2	7	6	6
4	4	2	3	8	5	5
5	4	3	1	10	8	7
6	0	0	0	5	5	5
Total during study	12	7	7	49	39	39
Percent		58%	58%		79%	79%

Interpretation, Table 31: The recovery of Staph aureus and Strep pyogenes in the placebo group remained at levels within our usual rates (80-95% strep, 60-90% staph) for a tropical climate. The recovery rates in the Hibitane group are lower than expected, but the small numbers involved suggest caution in interpretation.

Comment

This is the first topical antibacterial agent which has shown any effect on the prevention of common infections of the skin in a community at large. As in all other tropical areas we have studied, the infections were caused by Streptococcus pyogenes, usually secondarily infected with Staphylococcus aureus. Development of a topical cream or lotion for prophylactic use in military populations would appear to be feasible.

Gram Negative Infections.

Since 1960, we have maintained an interest in Gram negative colonization and infections of the skin, particularly as it relates to military personnel operating in wet environments.

From this interest has come the discovery of the Mimeae tribe (now known as Acinetobacter) as members of the cutaneous flora, the description of the "Pseudomonas toeweb" disease, the discovery of the Woods Light diagnosis of early pseudomonas infections in burns, the discovery of Pseudomonas cepacia as a colonizer of toewebs, the development of Dermatophyte Test Medium (DTM) for use in wet terrain mycology, and the ecological invasion of the skin by gram negative bacteria following the use of antibacterial soaps.

This approach of studying aquatic bacteria wherever they may cause problems prepared us for the more pragmatic applications of knowledge to life threatening human infections. While investigating potential sources of gram negative burn wound infection, we examined flower vases in a hospital environment and found them to be the most prolific reservoir in the hospital. Moreover, up to 50% of the bacteria in hospital flower vases were resistant to several aminoglycoside antibiotics.

The report was published as a lead article in "The Lancet" (Dec. 8, 1973, pp. 1279-1281). Only the summary is reproduced here.

Flower Vases in Hospitals as Reservoirs of Pathogens.

Summary: Flower vases on surgical wards and a burn unit in two Miami hospitals carried large numbers of potentially pathogenic bacteria in the water they contained. Bacterial counts reached 1×10^9 colony-forming units (C. F. U.) per ml. within 3 days of placing flowers in clean tap water. Counts of gentamicin-resistant bacteria in flower vases found on surgical wards reached 8 million C. F. U. per ml. of flower water. Among the species identified were Pseudomonas aeruginosa, Ps. cepacia, Ps. alcaligenes, Aeromonas hydrophila, Acinetobacter spp., Flavobacterium spp., Escherichia coli, Klebsiella ozaena, and Proteus mirabilis. Six of these species have previously been reported as causing hospital infections. These findings suggest that flowers should not be introduced into hospital areas occupied by susceptible or debilitated patients.

The most dramatic example of applied aquatic microbiology was unexpected, and occurred on December 29, 1972, when the first crash of the new generation of wide bodied jets occurred in the Everglades. The field report is reproduced here.

LOCKHEED 1011 TRISTAR JET CRASH
EVERGLADES, DECEMBER 29, 1972

Microbiological Studies Relating to Infections Among Survivors

David Taplin
Associate Professor, Department of Epidemiology and Public Health
University of Miami School of Medicine

Coinvestigators:
Patricia M. Mertz, Research Associate, Department of Dermatology, University of Miami School of Medicine, Dr. Gerald Gilardi, Hospital for Joint Diseases, New York, Dr. Richard Childers, Department of Dermatology, University of Miami School of Medicine, Lyle Lansdell, Research Assistant, Department of Dermatology, University of Miami School of Medicine, Dr. Nathan Schneider, Division of Health, Jacksonville, Florida.

This investigation was supported by U.S. Army Medical Research and Development Command and the Commission on Cutaneous Diseases of the Armed Forces Epidemiological Board contract DADA 17-71-C-1084.

Infections Among the Survivors of the Lockheed L-1011 (Tristar) Jet Crash in the Everglades

At 11:42 PM on Friday, December 29, 1972, a Lockheed L-1011 aircraft on route from New York to Miami crashed in a swampy, almost inaccessible area of the Everglades, approximately 18 miles west northwest of Miami International Airport.

There were 176 passengers and crew aboard. Seventy-five survived the impact. The area of impact was a sawgrass prairie, three to six feet high (Fig. 9 and Fig. 11). Water depth was one to two feet overlying four to six feet of mud (Everglades muck). The night was dark, with no moon, and because of the total disintegration of the aircraft there were no lights available at all for at least 30 minutes, and no adequate lighting to guide rescue efforts for over an hour. In the darkness, the survivors, most of whom were injured could do no more than wait for rescue. Movement of only a few feet was impossible because of the darkness, jagged wreckage and deep holes in the mud underfoot where wreckage had impacted into the terrain. There was a great deal of fuel, hydraulic fluid and oil released, which floated on the surface of the water (Fig. 10) The smell of jet fuel was so strong that none of the survivors attempted to light a match or cigarette lighter; a remarkable degree of restraint considering that wounded relatives and children might be drowning only a few feet away in the darkness. A rescue aircraft offered to drop flares but this was fortunately aborted at the last moment by an alert Coast Guard officer in radio contact. The individual acts of herosim in the Everglades that night were many, and with some reluctance are left out of this report.

Details of the crash, the rescue efforts and the findings of a Board of Enquiry are contained in National Transportation Safety Board Report Number NTSB-AAR-73-14.

Our studies are not included in the official reports, because this crash was unique in many respects, and because no system was in operation to investigate microbial hazards to survivors of aircraft crashes in wet terrain. Our team, supported entirely by this contract was therefore the only team involved in these aspects which we were able to predict by reason of our previous experience in wet terrain microbiology. The following is our story.

Background:

In 1965, in response to requests from the military to investigate immersion foot, we placed volunteers in the Everglades for several days and nights and showed that silicone grease could delay the onset of disabling warm water immersion foot (Taplin and Zaias, Military Medicine 131:814, 1966).

At that time we monitored the microbiology of the feet and were impressed by the colonization of the toewebs by gram negative bacteria, including Pseudomonas aeruginosa, which although clearly "wild" Everglades strains, were armed with proteinases capable of digesting the outer layers of the skin.

In 1966 during a study of U.S. Army Rangers at Eglin, Florida under swamp conditions, we again saw massive colonization of the feet by strange gram negative bacteria, which even overgrew culture media containing 100 μg/ml of gentamicin. We could not identify these odd bacteria for five years, when they eventually were found to be Pseudomonas cepacia (Taplin et al, Lancet II:568, 1971).

In 1968 during the training of LTC Alfred M. Allen's team from Walter Reed Army Institute of Research, we again witnessed the gram negative colonization of the skin among his team members operating in the Everglades, which accelerated our studies to perfect selective media for field use which later proved so valuable in Vietnam (Allen et al, Arch. Derm. 102:68, 1970 and Allen et al, Arch. Derm. 104:271, 1971).

In all of this we were hindered by our inability to identify many of the gram negative swamp bacteria, and we had a nagging suspicion that among them were human pathogens.

In 1972 in our investigations of burn wound infections, an airboat operator was burned extensively by an exploding gasoline tank, and he jumped into the Everglades swamps. He became infected with Aeromonas hydrophila, an organism known to us then only as a cause of red leg disease in frogs, and related to our knowledge of a fatal disease in salmon caused by Aeromonas salmonicida.

Thus it was that, as a result of our work under this contract, we were already aware of potential hazards when we heard of the crash of the Tristar jet on the night of December 29, 1972.

Methods:

On the first working day after the crash, we alerted all the local hospitals which had received survivors of the possibility of unidentifiable gram negative infections among the wounded, but we were already too late. Because of the intervening long New Years weekend, wounds were already heavily infected, and the hospital laboratories were up to their Bergey's Manual in unusual gram negative bacteria obtained from the wounds. Simultaneously a gas gangrene problem became evident, and it was clear that we were dealing with an unusual situation.

A U.S. Air Force helicopter from Homestead Air Force Base transported our team to the crash site, where we sampled bottom mud and water in a virgin area upstream of the impact point, and throughout the wreckage area. Even at that time (four days post-crash), there was heavy contamination of the wreckage area with jet fuel, oil and hydraulic fluid. In the immediate area of the crash, it was clear that something toxic was or had been present in the water (Fig.12). Dead frogs, snakes and fish were floating and the water samples, in comparison with the upstream samples were virtually devoid of larger microscopic life, (paramecia, rotifers, etc.).

One of our team wore waders; the other two wore U.S. Army jungle boots. The two unprotected members experienced acute burning and irritation of the legs, which rescue workers told us was due to hydraulic fluid. (This may well have played a role in the devitalization of tissue in the wounds, or an additional insult favoring infection)

We took duplicate specimens at all sites, and gave one set to the local Public Health and State Health authorities, since they were at that time better set up to study the anaerobic Clostridia, organisms which we do not normally have reason to study. We did, however, consult with Col. Robert Joy at WRAIR to support our feelings that even in the Mekong Delta, gas gangrene was not a major problem of wounds, because of early and extensive debridement of wounds, delayed closure and use of penicillin.

In Tristar survivors primary closure of the wounds was used in most cases. In one hospital, the wounds were reopened 48 hours after the crash because of the high infection rates and reports from other hospitals of gas gangrene.

Results:

We are still attempting to ascertain an attack rate for infections among survivors. Because of the number of hospitals involved, failure to keep data of this kind and different levels of microbiological monitoring it has proven to be a difficult task. It is certain, however, that rates of wound infections were of a much higher order than expected and were quoted as being from "more than half the survivors" to "most of them". We are attempting to examine all charts to ascertain rates in relation to injuries and antibiotic use. We have laboratory proof and histories of infection in 30 percent of those evacuated, but not all of them had open injuries, so that the rate for open wounds is likely to be much higher.

Because of the urgency of the situation, one of our team (Patricia Mertz) was sent to Dr. Gerald Gilardi's laboratory at the Hospital for Joint Diseases and Medical Center, New York, with all available cultures from the water and wounds, because they had an ongoing program in the identification of unusual gram negative bacteria, in contrast to our sporadic interest which has waxed and waned according to the military situations as they arose (immersion foot, WRAIR team, Vietnam).

It would have delayed us several weeks to establish a weird bacteria lab, in view of the more than 40 or so biochemical tests needed to identify them to species. We have since established such a capability.

Table 32 shows the organisms which were isolated from wounds in survivors, water and mud samples and a guinea pig model described later.

Aeromonas hydrophila was by far the most common pathogen in the infected human wounds and the guinea pig infections, and was recovered from the Everglades muck and water both before and after impact.

Animal Model:

We incised the skin over the thigh muscle of anesthesized guinea pigs, crushed the muscle five times with artery clamps, and injected the crushed tissue with 0.1 mls samples of water and bottom mud from a virgin area before impact, and with the top sludge of mud, jet fuel and oil in the wreckage area where most survivors were found. The wounds were lightly sutured. We attempted to treat the guinea pigs in a similar fashion to the human survivors, and half of those injected with wreckage sludge and virgin water were treated daily with gentamicin (10 mg/kg B.I.D., I.M.).

Table 33 shows the results of the guinea pig model. All animals which received virgin bottom mud or mud/kerosene "emulsion" which floated in the wreckage area developed purulent infections. Those which were treated with gentamicin developed less severe infections, and within one week, gram negative bacteria were eliminated from the wounds in this group.

Animals which were not treated with gentamicin developed more severe infections (Fig.14) and yielded at least four species of gram negative bacteria which were also recovered from the infections in the human survivors (Table 32).

No infection developed in animals receiving virgin Everglades surface water or saline.

Of further interest was the recovery from eight animals of β hemolytic streptococci which appeared to originate from the Everglades. No animals developed gas gangrene and no Clostridia were isolated one week after injury.

Discussion:

With the exception of P. aeruginosa the organisms isolated from the purulent wounds of the survivors are not readily identified in most hospital laboratories, and certainly are familiar to few clinicians. These environmental bacteria, however, are reported with increasing frequency as a cause of hospital infections*. In our our hospital, for example, Aeromonas hydrophila has been recovered from a brain abscess, a lung abscess, urinary tract infections, septicemia, and an infected burn.

Our data indicates that the gram negative bacteria which infected both human survivors of this crash and the guinea pigs were of Everglades origin. It also seems clear that the mud or Everglades "muck" was infective, but surface water was not. It should be emphasized again that in the wreckage area the bottom mud was disturbed and mixed with jet fuel, causing the mud to float on the surface. All survivors to our best knowledge were virtually coated with this emulsion.

It is also probable that the kerosene jet fuel and hydraulic fluid acted as additional insults or perhaps tissue devitalizing agents in the wounds. Unlike the gram negative infections, the gas gangrene infections did not appear to have arisen from organisms present in the Everglades. This aspect was investigated by Dr. Nathan Schneider of the Division of Health, Jacksonville, Florida who examined our water samples and human isolates. All of the isolates from the survivors were Clostridium perfringens. No C. perfringens

*Gilardi, G.L., Bottone, E., and Birnbaum, M. Applied Micro. 20:156, July 1970.

was isolated from the Everglades mud or water. Other species of Clostridia which were recovered from the swamps did not appear in human infections. We, therefore, do not know whether the human cases of gas gangrene were autogenous, derived from other injured persons, or perhaps from the spilled contents of the aircraft toilets.*

In view of the very low incidence of gas gangrene among combat casualties in Vietnam, even those injured in highly contaminated wet terrain, several questions remain unanswered relating to the survivors of this crash. We believe that primary closure of the wounds was the most important contributing factor favoring gas gangrene, and perhaps the gram negative infections as well. On the other hand, this was a unique crash, with a high percentage of survivors in view of the extensive disintegration of the aircraft, occurring in wet terrain, and involving contamination of wounds with mud, jet fuel, and hydraulic fluid.

We plan to investigate other air crashes in wet terrain in which there are survivors and have established a liason with the National Transportation Safety Board which we hope will enable us to do this.

This experience serves as a reminder that several species of gram negative bacteria which abound in natural waters may under the right circumstances produce infections in severely injured people. These organisms are usually considered of low virulence. In many thousands of man-hour exposures in the Everglades none of our team became infected, except for occasional P. aeruginosa infections of the toenails and transient toeweb infections.

Severe injuries in such terrain are clearly subject to colonization and infection by bacteria which may well be unrecognized, dismissed as contaminants or not sought after except in the larger sophisticated hospital laboratories.

We wonder what the sequellae of a large jet crash in wet terrain might be if it occurred in an area in which Pseudomonas pseudomallei (the causative organism of Meliodosis) is present. These areas include** Vietnam, Cambodia, Laos, Burma, Thailand, Malaysia, India, Ceylon, Borneo, the Phillipines, Guam, Indonesia, Madagascar, Chad, Netherlands Antilles, Panama, Turkey, and Ecuador. There is ample evidence that Meliodosis can occur following traumatic injuries in wet terrain, that the incubation period may be long, and may mimic T.B., cholera, typhoid, plague, systemic mycoses, amebic

*It was suggested that the aircraft fuel tanks may have been contaminated by C. perfringens. This aircraft had logged only 1000 hours, and the fuel is continuously scavanged from the bottom of the tanks, so that water condensation cannot accumulate. We therefore consider the fuel tanks as an unlikely source in this crash, and C. perfringens was not isolated from samples taken close to a ruptured fuel tank. Microbial contamination of aircraft fuel tanks is, however, a known phenomenon and should not be entirely dismissed as a potential source of bacteria.

** LTC Everett Cooper, MC, USA. JAMA 200:452, May 1967.

hepatitis, viral pneumonia, and can cause osteomyelitis, pyogenic arthritis, cellulitis, hepatic abscess, pneumonia, empyema, septicemia, and cutaneous abscesses.

Initial cultures and daily cultures and sensitivities should be mandatory for all wet terrain injuries. Unusual or difficult to identify bacteria should be referred to appropriate laboratories for identification. In air crashes in which survivors are sent to different hospitals, the laboratories and infection control officers at each hospital should maintain close liason so that they can alert each other to emerging microbiological problems.

Acknowledgements:

We wish to thank those who assisted in this investigation, usually with no warning and always without hesitation: Dr. Joel Nitzkin, Dade County Public Health Department, Dr. Paul Hughes, Broward County Health Department, Dr. Leon Termin, Pathologist, Palmetto General Hospital, Miss Carol Rose, Microbiologist, Palmetto General Hospital, Dr. Terrence Barry, Orthopedic Surgeon, Mr. Edward D. Dreifus, National Transportation Safety Board, the officers and staff of Palmetto General Hospital, Mercy Hospital, Hialeah Hospital, Eastern Airlines, USAF Homestead AFB.

Colonel Robert Joy, MC and Colonel Taras Nowosiwsky, WRAIR, also provided helpful advice and encouragement.

Addendum:

On September 2, 1973, a 17 year old girl was severely injured in a boating accident. Her right arm was traumatically amputated at the elbow, she had an open comminuted fracture of the left femur and severe lacerations to the body. She was flown to Miami by helicopter and underwent surgery at 9:30 PM. Wounds were debrided, left open, drains were inserted and wounds covered with dressings soaked in povidone-iodine solutions.

Two days later she had a fever, and pus was present in the wounds. Cultures yielded Aeromonas hydrophila, Pseudomonas aeruginosa and Enterobacter spp. She was placed on systemic gentamicin and cleocin. Wounds remain purulent for four more days, but six days after therapy was started, cultures were negative and wounds looked clean.

Comment:

The timing and species involved in this infection were similar to the Tristar jet crash survivors. This accident occurred in sea water, raising the possibility that these infections may not be solely confined to fresh water.

Update: We now have information on 16 further infections by A. hydrophila following wet terrain injuries in Florida. Two were minor wounds in diabetes and both patients died. Fish and alligator kills have also been attributed to A. hydrophila.

Organisms Isolated From Wounds	Organisms Isolated From Everglades Mud or Water	Organisms Isolated From Guinea Pig Injury Model
*Aeromonas hydrophila	Aeromonas hydrophila	Aeromonas hydrophila
*Pseudomonas aeruginosa	Pseudomonas aeruginosa	----
*Pseudomonas putrefaciens	Pseudomonas putrefaciens	Pseudomonas putrefacien.
----	Pseudomonas fluorescens	----
----	Pseudomonas maltophilia	----
----	Pseudomonas alcaligenes	----
*Plesiomonas shigelloides	----	Plesiomonas shigelloides
*Enterobacter cloacae	Enterobacter cloacae	----
Edwardsiella tarda	----	----
*Citrobacter freundii	----	Citrobacter freundii
*Acinetobacter anitratum	Acinetobacter anitratum	----
Acinetobacter lwoffii	----	----
Alcaligenes faecalis	Alcaligenes faecalis	----
----	Klebsiella oxytoca	----
Klebsiella pneumoniae	----	----

*Organisms which were recovered from virgin mud and soil upstream of impact.

TABLE 32

AD-A060 212 MIAMI UNIV FLA DEPT OF DERMATOLOGY F/G 6/5
FUNGOUS AND BACTERIAL SKIN INFECTIONS IN THE TROPICS.(U)
AUG 78 D TAPLIN DADA17-71-C-1084
UNCLASSIFIED NL

2 OF 2
AD A060 212

END
DATE FILMED
-12-78
DDC

RESULTS OF GUINEA PIG MODEL
ONE WEEK AFTER INJURY

Source of Inoculum and Treatment	Number of Animals	Clinical Infection*	Mixed Gram Negative Bacteria	β Hemolytic Strep (Not Group A)
Surface water before impact; no treatment	4	0	0	1
Surface water before impact; treated with gentamicin	4	0	0	0
Top sludge from wreckage area	4	3 severe +1 died	3	3
Top sludge from wreckage area; treated gentamicin	4	4 moderate	0	2
Bottom mud before impact; no treatment	2	2 severe	2	2
Saline	2	0	0	0

*Clinical infection was evident as swelling and erythema of the limb, with purulent exudate. It was graded as moderate to severe on the degree of swelling and erythema.

TABLE 33

Figure 9 Aerial view of wreckage site. Massive disintegration of fuselage. Wreckage scattered in small pieces for a distance of 1600 feet from point of impact.

Figure 10 Wreckage site, ground level. Remains of aircraft lying or buried in 2 feet water overlying four to six feet of mud. Oil, jet fuel and hydraulic fluid covers entire area of wreckage.

Figure 11 In spite of almost total disintegration of fuselage, most survivors were found in or close to largest pieces of wreckage.

Figure 12 Dead snakes, frogs and fish in area of wreckage indicated contamination of terrain by toxic materials.

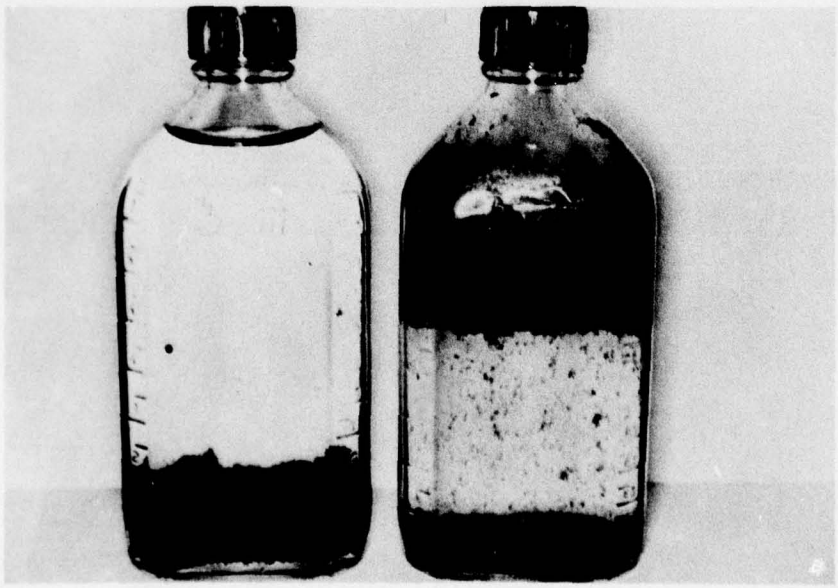


Figure 13 Environmental samples: Bottle on left contains virgin water and mud before impact. Bottle on right from wreckage area demonstrates floating sludge of jet fuel, hydraulic fluid and mud.

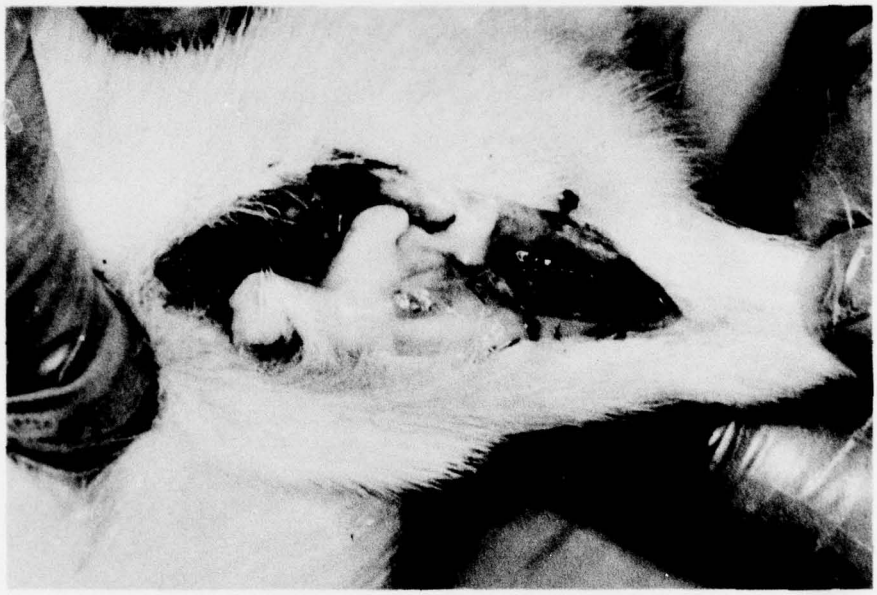


Figure 14 Untreated guinea pig two weeks after injection 0.1 mls "top sludge" from wreckage area into thigh wound. Large amount of pus deep in muscle yielded Aeromonas hydrophila, Pseudomonas spp., and Plesiomonas shigelloides.

DIAGNOSTICS AND FIELD METHODS.

None of the accurate epidemiology contained in our progress reports, nor the field work in Vietnam could have been conducted without developing new or improved methods for field use. The most useful methods are listed below, with updated comments.

1) Dermatophyte Test Medium (DTM): A highly selective indicator medium for the diagnosis of dermatophytosis and candidiasis, and for isolating dermatophyte fungi from environmental sources. DTM continues to perform admirably when made exactly to specification. All of the epidemiology in Vietnam, our work in Colombia, Venezuela, Costa Rica and Uganda was based on DTM, and all of the clinical FDA trials in the U.S. on miconazole, clotrimazole and haloprogin used this method.

Unfortunately, some manufacturers produced inferior brands of DTM or substituted ingredients. Two manufacturers have consistently produced authentic DTM which has performed well in the field. They are:

DTM Clinical Sciences Inc., Whippany, N.J.
"Fungassasy" medium. Pittman-Moore Co.

We have no consultantship or other relationships with these companies.

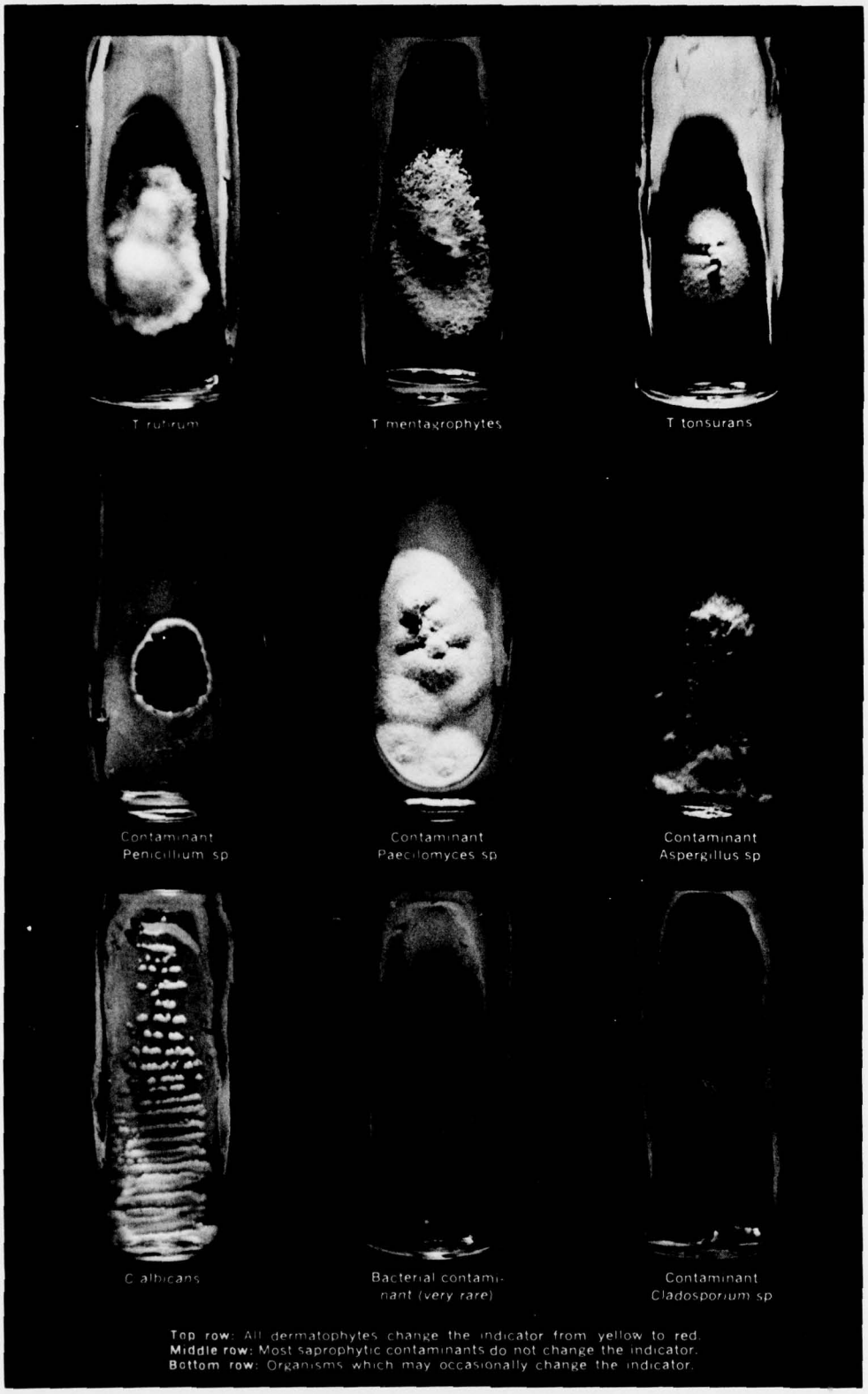
2) Trypticase Soy Agar with 6% Sheep Blood and 0.8% Crystal Violet (TSAB-CV): A selective enriched medida for the isolation of Streptococcus pyogenes. Used in all field studies since 1968. Consistently yields high recoveries of streps from skin lesions. Superior to plain blood agar, neomycin/blood agar, and phenyl ethyl alcohol/blood agar when used in the field. Use only Difco "Bacto" certified crystal viole

3) PYM II : A selective, indicator media for the isolation of Staphylococcus aureus. Contains actidione, polymyxin B, mannitol, yeast extract and Brom cresyl purple. Coagulase positive S. aureus turn the normally purple medium to bright yellow. Other bacteria and fungi are inhibited. Consistently gives higher yields than non-selective media, and easily interpreted by non-skilled personnel. Plates should be incubated no longer than 36 hours, after which some bacteria may break through selective agents in media.

4) Silica Gel Dessication of Swabs: (Applied Microbiology June 1973 p. 135-138). Available in kit form. Enables accurate field epidemiology of streptococcal pyoderma without need for fresh media. Dessicated swabs can be mailed to receiving labs and cultured up to 2 months later. Not recommended for normal skin sampling or throat swabs.

5) KOH/DMSO: For rapid microscopic examination of skin, hair and nail scraping for fungi. Particularly helpful in large scale screening. Use with caution; caustic to human skin and microscopes.

6) Field Incubator: A large size metal "Coleman" beer cooler was converted to a



Top row: All dermatophytes change the indicator from yellow to red.
Middle row: Most saprophytic contaminants do not change the indicator.
Bottom row: Organisms which may occasionally change the indicator.

Reprinted from the Archives of Dermatology
February 1969, Volume 99

field incubator capable of operating on 110 volt AC or 12 volt DC. It has proven invaluable in the field, and has enabled us to conduct bacteriology in the most remote areas, and to incubate cultures during transit between stations by simply plugging into the jeep wiring system. Previous to this, finding incubator facilities in the field represented a major logistical problem.

The cooler also serves as a means of transporting sterile media to the field site where cultures are made, and eliminates the need to return to the base station for incubation.

Armed with the above methods, a field team can cover most of the common causes of cutaneous infection. In appropriate circumstances, the system is easily expanded to include other methods, such as selective media for C. diphtheriae, acid fast bacteria, and methods to identify cutaneous leishmaniasis. The availability of disposable biopsy punch kits further enhance field capabilities.

SAFETY AND HEALTH OF FIELD TEAMS

By definition, this contract required field teams to operate under adverse conditions in areas endemic for several tropical diseases. In addition to the usual hazards of "traveler's diarrhea", in the last ten years we have found ourselves in the midst of malaria, Chagas' disease, tuberculosis, cutaneous leishmaniasis, typhoid fever, onchocerciasis, and dengue.

We believe there is a responsibility on the part of institutions and team leaders to protect their personnel as far as possible from known hazards. Apart from the moral and possible legal issues, a sick team member cannot fulfill his or her functions and becomes a liability to the project.

In our early days, we suffered our usual share of gastrointestinal disturbances, and decided in the late sixties to take more active preventive measures. Our system has been continuously updated, with the result that we can now report no incidents of G.I. infection or other infectious diseases in the last 2083 person days in the field, with 4 exceptions which will be outlined. Basically, we institute rigid requirements for all field teams.

Preparation:

1) Up to date shots for tetanus, yellow fever, and a gamma globulin shot just prior to leaving country. We do not recommend smallpox vaccination. Malaria prophylaxis is started one week prior to departure.

2) Clear chest X-ray and P. P. D. skin test. Skin test negative personnel are offered B.C.G. vaccination at least six weeks before departure, or prophylactic INH for short term in-country coverage.

3) Heat acclimatization and physical exercise starting 3 weeks before leaving for tropical area.

4) Orientation on reservoirs, insect vectors, signs and symptoms of tropical diseases, explanation of field regulations, and available methods of therapy. Particular attention is paid to insect protection, and safety rules for food and drinks.

In The Field:

1) No drinking of untreated or unboiled water. All drinking water is to be boiled, or treated with iodine type purification pills and passed through activated charcoal to remove taste. An elegant kit is now available (Waterpick, Instapur*).

2) No ice in drinks.

3) No salads, uncooked foods, cold cuts, cole slaw, potato salads, etc.

4) Bottled and canned drinks and juices are considered safe.

5) Fresh fruits to be soaked in iodine water before peeling.

6) Rigid insect protection. Long sleeves and pants for morning and evening. Liberal use of repellents (Army issue if available, or "Deep Woods Off";* or "Cutters"*). No sleeping in native dwellings. One piece nylon tents with intact fly screens.

7) Awareness of endemic levels of active T. B. Avoid very close contacts (kissing babies, etc.).

Rigid application of these simple rules have kept our field teams healthy through fifteen field studies. Comparison of our attack rates with other field teams or workers in the same areas suggest that our methods are effective Fig. 15 Bacterial diarrhea and/or giardiasis and amoebiasis affected 50% of 26 students in Guatemala, 10 of 12 airline employees visiting Colombia, all of five health workers in Costa Rica, and 18 of 22 geology students in Guatemala. Additionally, 7 of these 22 were hospitalized with hepatitis.

5 of 7 medical students with negative P. P. D. skin tests converted to positive after on month in Honduras, working in a rural pediatric hospital. The only four failures in our teams during the last four years were diarrhea in two students who deliberately and secretly ignored the rules, and one field experienced nurse who followed all rules relating to ingestion, but who self administered a large volume enema to relieve constipation. Within 18 hours, she developed massive diarrhea which is still under investigation at this time. The fourth case followed precautions, but drank several piña-coladas without ice. The pineapples used were homogenized in a blender owned by a Peace Corps nurse later found to have amoebiasis. Our team member did not respond to antibacterial therapy for two weeks, but did respond to a full course of Flagyl.

We have had four episodes of streptococcal skin infection of abrasions or insect bites while working with hundreds of children with infected scabies in

* We have no consulting or other relationship with these companies.

Panama. We took no precautions to prevent this, but we will use topical chlorhexidine gluconate in the future.

Although we have avoided diarrheal diseases except for the fourcases described, constipation among women team members has been a problem. 9 of the last 10 women in the field suffered from this, compared with 1 of 17 males. This difficulty occurs in the first two weeks in country, and we believe it relates primarily to emotional factors surrounding the primitive toilet facilities available to us.

Possible lack of vitamins from fresh fruits and vegetables can be replaced by daily multi-vitamin pills, or use of powdered "Tang". Our teams frequently experienced upper respiratory infections with the symptoms of the common cold. We assume this to be of viral etiology from strains foreign to our previous experience. We also monitor urine output as a guide to fluid intake, because the losses through sweating are considerable in the tropical areas in which we work. Fluid intake must be dramatically increased to maintain near normal output. We do not take salt pills, but have noticed that team members tend to use salt liberally with evening meals after a long hot working day.

When heat stress is severe (above 92 WBGT index), we revert to the "wet T-shirt" technique, in which members wear wet shirts to aid in evaporative cooling. We also have found value in taking small and frequent amounts of sugar in the form of "Kool Aid" or candies during exhausting jungle treks, as a rapid replacement for the additional calories expended.

WBGT index. We have found the field WBGT measuring kit useful. (Weksler Inst. Corp. Fed. Stock No. 6665-159-2218). It suffers from one defect. The aluminum shield over the dry bulb thermometer gets hot, and radiates heat to the thermometer bulb, producing a false reading. This can be overcome by using a spearate thermometer placed in nearby shade.

In summary, the safety and health of field teams in the tropics can be maintained by adopting a "military" approach. Preparation and orientation are important, and there must be a clearly defined team leader responsible for health and safety. In addition, individual self discipline is essential, and we have found that detailed education on the potential sequellae of such diseases as amoebiasis and Chagas' disease acts as a powerful reinforcement of daily precautions.

All personnel are required to sign a statement that they understand the potential risks and precautions required. Although we have never had a drop out, all members of our civilian teams are free to discontinue participation and return home for any reason.

Location	Occupation	No. persons at risk	Person/Days in country	No. with diarrhea	No. with hepatitis	P. P. D. conversion
San Blas Panama 1977-78	Med. Students and nurses	23	644	0	0	0
Colombia North & Central 1977	Field Research Team	2	112	0	0	0
Guatemala Central 1976	Disaster Team	14	196	0	0	0
Guatemala Traveling 1978	Geology Students	26	676	1*	0	N. D.**
Santa Rosa, Honduras 1977	Med. Students	4	112	0	0	0
Parrita, Costa Rica 1977	Field Research Team	15	315	1*	0	0
Belize 1978	Nurse and Photographer	2	28	2*	0	0
		71	2083	4 (6%)	0	0

* 2 broke rules. 1 inoculation by enema, and 1 drank pina colada from potentially contaminated blender
** Not determined.

Fig. 1 5. Attack Rates of Infections in 71 Persons on Strict Precautions in the Field.

Location	Occupation	No. persons at risk	Person/Days in country	No. with diarrhea	No. with hepatitis	P. P. D. conversion
Bogota, Colombia 1977	Tourists	12	84	10	0	N. D. *
Antigua, Guatemala 1978	Language Students	26	728	13	1	N. D.
Guatemala Traveling 1977	Geology Students	22	572	18	7	N. D.
Santa Rosa, Honduras 1976	Medical Students	7	196	7	0	5
Parrita/Quepos, Costa Rica 1977	Health Volunteers	5	840	5	1	N. D.
Total		72	2420	53 (74%)	9 (12%)	5

* Not determined

Fig. 1 6. Attack Rates of Infections in 72 Persons Without Precautions in the Field.

I am particularly proud of the dedicated and skillful personnel who over the years of this contract worked long hours, often under miserable conditions without complaint. They include:

Maria del Carmen Arrué	Bryan Frederick, M. D.
Joel Bamford, M. D.	Gladys Guerra
Helen Bennet	Lyle Lansdell
Sandra Breiterman	Jan Mason, M. D.
Isis Caldevilla	Patricia M. Mertz
Gregory Crawford, M. D.	Bruce Murray, M . D.
Susan Dunitz	Donna Reno, R. N.
William Eaglstein, M. D.	Gwen Scott, M. D.
Karen Elliott	Joseph B. Tucker, M. D.
Richard Feinstein, M. D.	Jane Graham Walker, R. N.

We all owe much to Gerbert Rebell, for 18 years of continuing education in mycology.

ACKNOWLEDGEMENTS

Throughout the many years of involvement with military related cutaneous problems, we owe much to our in service colleagues and foreign hosts. To list them all would take considerable space and risk inadvertent omissions. Certain individuals played particularly vital roles and deserve special mention.

To Col. Alfred M. Allen, M.C., our friend, mentor and hard nosed critic, many sincere thank you's. To Col. William Akers, M.C., for much advice, genuine concern and for always being a gentleman. To Col. Robert J. T. Joy, M.C., for decisive action and sound judgement when we were in doubt.

To a succession of contract officers faced with the perennial difficulties of trying to match our Annual Progress Reports to contract proposals, invariably with little success. To the in-house investigators and laboratory personnel at WRAIR and LAIR, who shared their work and time with us. To the many military commanders and NCO's at Ft. Benning, Ranger School, Lackland Air Force Base, and Homestead AFB who never withheld support and provided facilities and personnel.

Overseas, we owe much to the Commanders of the 2nd, 4th and 10th Brigades, Colombian Army, who made their officers and men available and for providing much logistical support. Essential to our overseas work were Dean Eugenie de Monge, and Dr. Roger Bolanos, University of Costa Rica, and Dr. Herbert Weinstock, Minister of Health, Costa Rica. Dr. Clemente Lara and Dr. Angela Restrepo, Medellin, Colombia, and Ms. Amparo Motta in Bogota gave many hours and essential facilities to our projects. In Panama, Dr. de la Ossa, and Drs. Castillero, Rodriguez and Matta of the Ministry of Health were invaluable, as was the USAID mission. Work in Venezuela would not have been possible without the efforts by Dr. Kerdel

Vegas and Dr. Jaunito Convit.

To Dr. Harvey Blank of the University of Miami for allowing this programme to flourish within and often without his department, for advice and criticism, but most of all for interest without interference, a rare and much appreciated talent.

David Taplin.

David Taplin
University of Miami School of Medicine.

KEY WORDS.

skin infections

climate

hygiene

insect vectors

streptococcal pyoderma

furunculosis

gram negative bacteria

epidemiology

field teams (health of)

Colombia

Uganda

Venezuela

Costa Rica

Guatemala

Vietnam

Panama

Tinea corporis

Tinea cruris

Tinea pedis

clothing

occlusion

griseofulvin

nystatin

tolnaftate

clotrimazole

antibacterial soaps

miconazole

hydrocortisone

diagnostic methods

selective culture media

streptococcus pyogenes

staphylococcus aureus

dermatophytes

candida albicans

pseudomonas

aeromonas hydrophila

Not included in this report but experience and data available if needed:

disaster relief
scabies
head lice
sun screens

DISTRIBUTION LIST

4 copies	HQDA (SGRD-AJ) Fort Detrick Frederick, MD. 21701
12 copies	Defense Documentation Center (DDC) ATTN: DDC-TCA Cameron Station Alexandria, Virginia 22314
1 copy	Dean School of Medicine Uniformed Services University of the Health Sciences 4301 Jones Bridge Road Bethesda, Maryland 20014
1 copy	Superintendent Academy of Health Sciences, US Army ATTN: AHS-COM Fort Sam Houston, Texas 78234